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ABSTRACT

This curriculum supplement was designed to correlate directly with "A Guide to Curriculum Planning in Technology Education," published by the Wisconsin Department of Public Instruction. It is also a companion book to three other classroom activity compilations, one in each of the other three major systems of technology--construction, communications, and transportation. The entire set--the curriculum guide and the four activity books--follows the content organization given in the "Technology Education Content" fold-out chart in this guide. The activities are organized on the basis of how each supports one of the manufacturing concepts identified on the chart. Materials for this supplement were gathered from throughout Wisconsin and several other states, and most of them were developed by teachers. The four sections of the guide include 21 activities grouped under the following topics: capital, secondary processes, management functions, and managed activities. Each activity consists of a description, resources needed, objectives, evaluation focus, procedures, information sheets illustrated with line drawings, and (sometimes) tests and answer sheets. (KC)

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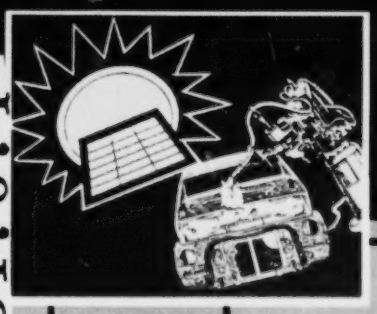

Technology Education

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CLASSROOM ACTIVITIES IN MANUFACTURING

CE054944

Wisconsin Department of Public Instruction
Herbert J. Grover, State Superintendent

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Foreword

Technology education is particularly well-suited to respond to our "Education for Employment" initiative and to facilitate career exploration for our students. The classroom activities in this resource relate directly to the technology of manufacturing, one of the four major systems identified in *A Guide to Curriculum Planning in Technology Education* as vital for helping students to understand the technological concepts and processes of the world around them. The other three systems are communications, construction, and transportation, and the Department of Public Instruction has prepared a compilation of relevant activities in each of those systems as well.

As teachers use the concepts contained in the guide and in these companion activity books, we hope they will develop new teaching directions that will enhance students' understanding of technology education and its impact on their present and future lives and careers. We must ensure the timeliness of this particular curriculum because we live in a world affected in every aspect by a variety of sophisticated, often baffling, technologies. In manufacturing, for example, we have microprocessor-controlled robots, new uses of tools, new materials, and the integration of computers into many and varied aspects of manufacturing processes. It is possible to envision completely new and different manufacturing processes bringing immense social change.

Technology education must take responsibility for imparting a basic understanding of the technological foundations of the many aspects of manufacturing. Materials, products, processes, problems, uses, and developments in the field of manufacturing must be an ongoing study, and timely occupational skills must be developed in our students.

These activities have been gathered to facilitate those ends. We encourage teachers, as they use these activities, to modify, expand, and reorganize them to fit individual classroom needs. These activities are intended to be subject to change and continuous improvement, so the Department of Public Instruction welcomes suggestions from users.

Herbert J. Grover
State Superintendent

Acknowledgments

It is not possible to list each teacher or agency that contributed to this collection of activities. Yet without the efforts of many in the field, this publication would not have been possible. We thank everyone that helped assemble this collection for graciously responding to our requests and for freely sharing their knowledge.

Special thanks are due to John Vanderhoof, former Department of Public Instruction (DPI) technology education consultant, for his part in gathering and clarifying the activities; to Dr. Leonard F. Sterry, program director for technology education majors, at the University of Wisconsin-Stout, who provided the original format and organized data collection from the field; and to Dr. Eunice Bethke, Chief, Consultation Section, DPI, for her facilitation and support.

Other DPI staff should also be acknowledged, especially Kathleen D. McCleave, editor of this supplement, for her efforts to find a consistent format and language for the activities and for her insistence on clarity and accuracy in the instructions. She was assisted with book design and graphics by Lisa Buckley. Additional thanks go to Barbara Sumwalt, technology education program assistant; Danni Jorenby, word processor/typesetter; and Kris Whitman, proofreader.

Introduction

This curriculum supplement, *Technology Education: Classroom Activities in Manufacturing*, was designed to correlate directly with *A Guide to Curriculum Planning in Technology Education* published by the Wisconsin Department of Public Instruction (DPI). It is also a companion book to three other classroom activity compilations, one in each of the other three major systems of technology—communications, construction, and transportation.

The entire set—the curriculum guide and the four activity books—follows the content organization given in the "Technology Education Content" fold-out chart. Thus, the activities in this particular book are organized on the basis of how each one supports one of the manufacturing concepts identified on the chart. An activity listed as "1C," for example, would have to do with "Capital," one of the "Input (Planning Factors)"; an activity listed as "2C" would relate to the "Secondary Processes " of the "Production Processes" of manufacturing.

Materials for this supplement and the companion documents were gathered from throughout Wisconsin and several other states. Most of the activities were originally developed by individual instructors who are actively teaching portions of the technology education curriculum. Some were developed by state departments of education and by projects supported by those agencies. Still other materials were developed at universities. Since this was a process of *collection*, not *creation*, of materials, some content concepts are not covered at all, and others are represented by several activities. Also, as a collection of activities, this supplement does not contain a master plan for utilization and does not represent full courses. Instructors must identify major themes to be taught in support of these activities, such as the research and development process, system components, safety and tool/machine use, input-process-output model, and so on. In this regard, the content chart can be a useful tool for the development of courses consistent with the philosophy of technology education.

Due to the process used to solicit and assemble these activities, there are additional points that should be kept in mind while using this material.

- The three-hole punched format was selected to permit the publication of the best activities available now, while making it easy to revise and update the activities later. Teachers are encouraged to share new activities as they are developed, or to suggest refinements of the present ones.
- Some activities could be used to support more than one content concept. While an attempt was made to make the best match possible, in some cases an arbitrary decision was made as to placement. Teachers are encouraged to modify placement if it seems more appropriate for a local curriculum.
- Activities were developed in the field, not the office. As a result of individual teacher input,
  — there is not necessarily an activity supporting each concept in the content chart; but there may be more than one activity for some concepts; and
  — the level, language, and length of the activities varies widely.
- An "evaluation focus" has been suggested but individual teachers may wish to change, or add to, the evaluation process.
- Answer sheets are provided where they were provided to DPI or where they seemed necessary, but not all activities have them.
- Activities are usually addressed to one student, but group work is an appropriate modification, depending on an individual teacher's intent for the activity.
- In activities where safety hazards may exist, teachers should note "Cautions" throughout the activity and call them to the attention of students.

- Any of these materials may be copied for student use without restriction. The format was designed to facilitate reproduction in the field.
- The use of brand names (*Apple* computer, specified software) is not meant as a commercial endorsement.
- Some activities are self-contained, but most of them require lecture and/or demonstrations by the instructor.

Technology Education Content

This chart graphically depicts a content organization for the four major systems of technology—communications, construction, manufacturing, and transportation. Within each system, major instructional concepts are identified by number and letter and their specific subject matter is detailed.

The chart is the basis of the technology education program and content models presented in *A Guide to Curriculum Planning in Technology Education* (Madison, WI: Department of Public Instruction, 1988). Awareness and introductory level courses in technology education are drawn from the broad overview of the discipline presented in the first two vertical divisions of the chart. The detailed content necessary for exploratory and elective courses in each technological system comes from horizontal views across the last three divisions of the chart.

The chart is also the organizational basis for this supplemental classroom activity manual in manufacturing. Each activity is keyed to one of the instructional concepts identified on the chart. The curriculum planning guide and activity manuals in the other three technology systems—communications, construction, and transportation—are available from the Department of Public Instruction.

TECHNOLOGY EDUCATION CONTENT*

Technology	Communications	1. Graphic	A. Printing Systems and Processes B. Photographic Systems and Processes C. Industry Products D. Industry Impacts	Relief • Screen • Lithography • Gravure • Electrostatic • Ink Jet Film Imaging • Electronic Imaging Paper/NonPaper Materials • Consumable/Permanent Uses • Film • Print • Video Economic • Political • Values/Attitudes • Environment • Aesthetic
		2. Electronic	A. Telecommunications Systems and Processes B. Hard-Wired Systems and Processes C. Computer Systems and Processes D. Industry Products E. Industry Impacts	Radio • Radar • Television Telephone • Telegraph • Public-Address Systems Analog • Digital Entertainment • Information/Data • Detection/Control • Computations • Data Exchange Economics • Political • Values/Attitudes • Environment
		3. Light	A. Interactive Systems and Processes B. Passive Systems and Processes C. Industry Products D. Industry Impacts	Laser • Fiber Optics Signs • Flashing Signals Entertainment • Information/Data • Detection Economic • Political • Values/Attitudes • Environment
		4. Acoustic	A. Sonic Detection Media and Processes B. Storage and Retrieval Systems and Processes C. Industry Products D. Industry Impacts	Gas • Liquid • Solid Phonographs • Tape • Disks Information/Data • Detection/Control • Entertainment Economic • Political • Values/Attitudes • Environment
	Construction	1. Planning Processes	A. Research and Development B. Marketing C. Industrial Relations D. Financing	Initiating the Project • Developing the Project • Implementing Analyzing the Market • Establishing Strategy • Promoting • Closing the Sale Hiring • Training • Providing Benefits • Providing Career Options Appraising Property • Estimating Costs • Funding • Documenting • Budgeting
		2. Production Processes	A. Preparing the Site B. Building the Structure C. Installing Utility Systems D. Enclosing the Structure (Rough Finishing) E. Finishing the Structure (Fine Finishing) F. Completing the Site G. Servicing the Project	Clearing • Setting up Temporary Facilities • Surveying • Earthworking Setting Foundations • Building the Major Structural Elements Installing Permanent Utilities and Mechanical Plant • Providing Temporary Equipment Preparing Materials • Handling Materials and Components • Assembling in Place Prep. Subsurfaces • Prep. Materials • Handling Materials • Trimming • Removing Equip. & Debris Removing Temporary Plant and Facilities • Landscaping • Building Features • Shaping the Finishing Earth • Removing Landscaping Equipment and Debris Diagnosing/Troubleshooting • Repairing • Altering • Installing • Maintaining
		3. Managerial Processes	A. Planning B. Organizing C. Directing D. Controlling	Formulating • Researching • Designing • Engineering Structuring • Supplying • Scheduling • Routing • Storing Coordinating • Assigning • Supervising • Inspecting • Authorizing Monitoring • Reporting • Correcting
	Manufacturing	1. Input (Planning Factors)	A. Material B. Human Resources C. Capital D. Finance E. Knowledge F. Energy	Direct • Indirect Managerial • Scientific/Technical • Office/Clerical • Worker/Operator Plant • Equipment Debt • Equity Technological • Scientific • Humanities • Formal
		2. Production Processes	A. Extracting B. Primary Processes C. Secondary Processes	Drilling • Harvesting • Mining • Other Thermal • Chemical • Mechanical • Electrical Casting and Molding • Forming • Separating • Conditioning • Assembling • Finishing
		3. Managerial Processes	A. Management Functions B. Types of Managed Production C. Managed Activities	Planning • Organizing • Actuating • Controlling Custom • Intermittent • Continuous Establishing the Organization • Designing the Product • Preparing to Produce • Producing • Delivering • Serving • Controlling the System
		4. Outputs	A. Primary Outputs B. Other Outputs	Raw Materials • Industrial Goods • Finished Goods Scrap • Pollution
	Transportation	1. Planning Base	A. Elements of Transportation B. Conquest of Time and Space C. Foundation D. People Systems E. Material and Goods Systems F. Mediums	Human Mobility • Movement of Goods and People • Physical—(Natural and Human Produced) Inventions • Innovations Personalized • Mass Transit Natural Forms of Movement • Technologies of Transport Land • Water • Air • Interrelated
		2. Transporting Processes	A. Receiving B. Holding/Storing C. Loading D. Moving E. Unloading F. Delivering	People (Personalized and Mass Transit) • Materials/Goods (Bulk, Gross, Packaged) People (Personalized and Mass Transit) • Materials/Goods (Bulk, Gross, Packaged) Manual • Manually-Operated Mechanical • Mechanized • Hybrid Terrestrial (Personalized and Mass Transit, Cargo–Bulk/Unit) • Marine • Atmospheric • Space Automated/Mechanized • Manual/Mechanized • Manual • Hybrid Means of Delivering to Final Destination
		3. Technical Systems	A. Energy Sources B. Energy Conversion C. Propulsion D. Suspension E. Control F. Guidance G. Structural H. Support	Electrical • Chemical • Kinetic • Gravity • Mechanical • Magnetic • Solar • Nuclear Internal Combustion • External Combustion • Hybrid Systems Mech. Drive • Hydraulic Drive • Electric Drive • Vacuum • Gravity • Reaction • Storage Devices Mechanical • Fluid • Magnetic Velocity • Directional • Attitude • Altitude • Vehicular and System Control Guideways • On-Board and External Devices • Interrelationship of Guidance and Control Vehicular Design Considerations • Guideway Design Considerations • Support System Structures Physical Facilities • Personnel • Regulatory Factors • Operational Systems
		4. Environmental Factors	A. Human/Social B. Economic/Service C. Physical/Functional D. Aesthetics E. Interrelated	Safety • Human Values & Desires • Enhancement of Social, Recreational, Cultural Prog. & Facilities • Comfort/Convenience • Demand Responsiveness • Service for Handicapped & Disabled • Privacy Transportation Costs • Access to Employment Opportunities • Efficiency Effects on Land Use • Adaptable to Future Needs • Flexibility • Adaptable to Intermode Operation General Appearance • Conservation of Natural Resources Noise Level • Pollution Characteristics • Neighborhood Growth and Development • Accessibility

*Based on taxonomies appearing in Thomas Wright and Leonard Sterry (co-directors). *Industry and Technology Education: A Guide for Curriculum Designers, Implementors, and Teachers.* Lansing, IL.: The Technical Foundation of America.

(1C) Capital

Manufacturing

Playing the Stock Market, an activity supporting the Input (Planning Factors) concept, is designed for up to 12 weeks.

Resources Needed

Materials

Daily newspapers with stock listings

Objectives

The student will

learn how to read and understand the stock listings in a daily newspaper;
follow an investment over a 12-week period; and
calculate his or her profit or loss.

Evaluation Focus

☒ Knowledge	☐ Problem Solving	☒ Attitude
☐ Awareness	☐ Machine/Tool Usage	

Playing the Stock Market

Procedure

Have you ever heard of the stock market? Do you know what the Dow Jones averages are? Do you understand the small numbers and figures that appear on the financial section of the newspaper?

Following is a section that would appear in the stock market report of a newspaper.

Stocks	Div.	Sales (HDS)	High	Low	Last	Net Change
AM Motor		353	8 3/4	8 5/8	8 3/4	
Atlas Corp.	45	56	2 3/8	2 1/8	2 1/4	
Bendix	1.60	173	24 3/4	23 3/4	23 3/4	-1
Camp S	1.18	74	31 5/8	31	31 1/8	-1/4
East Airln		357	6 1/8	5 3/4	5 3/4	-3/8
Latrobe Stl.		17	6	5 7/8	6	
McDonal		7	3	3	3	
St Oil Ind	2.68	839	107 1/2	98 1/4	98 1/4	-10 1/2
Scott Pap	.56	304	15 7/8	15 1/8	15 1/2	-1/2

The following explanations will help you read and understand the stock report.

Stocks—This is a listing of companies offering to sell stock. Often company names appear as abbreviations. The stocks are listed in alphabetical order.

Div.—This stands for dividend. A dividend is the amount of money a stockholder received for each share of stock held at the end of a period. If you look at the above report, you will see Campbell Soup (Camp S) paid $1.18 per share held.

Sales (HDS)—These numbers stand for the number of shares *in hundreds* that were sold during the day. For instance, 74 would stand for 7,400. Campbell Soup sold 7,400 shares on this day.

High—This is the highest price paid per share of stock for that day.

Low—This is the lowest price paid per share on that day.

Last—This column stands for the closing price paid for a share of stock on that day. This is the price used to figure daily profits and losses while playing the market.

Net Chg.—This is the last column listed. It represents the difference between yesterday's and today's closing prices. Symbols of "+" and "–" appear before the net change. A "+" would mean the stock increased in value from yesterday, and a "–" would mean it decreased. Stocks are listed in 1/8's or $.12 fractions.

1. Study the sample market chart and answer the questions on the Student Response Sheet.

2. Assume you have $1,000 to invest in the stock market. Study the daily paper and determine which company or companies (up to three) you would like to invest in. Think about how much one share costs, and determine how many shares you can buy in each company and how much your total investment will be. Record all data on the "Weekly Market Quotation" section of the Student Response Sheet, keeping a daily record of your stock's activity. You must sell your stock at the end of 12 weeks and calculate your profit or losses.

Playing the Stock Market

Name _____

Class/Period _____

1. What was American Motors' closing price?

2. What was the net change of Bendix?

3. What was the day's high for McDonald's?

4. What was the day's low for Latrobe Steel?

5. How much of a dividend, per share, did a stockholder of Scott Paper receive for the last period?

6. What is the abbreviation for Eastern Airlines?

7. What is the abbreviation for Standard Oil of Indiana?

8. How many total shares, in hundreds, of Xerox Corporation stock were traded?

	Company 1			Company 2			Company 3		
Source of Readings									
No. of Shares									
Initial Investment									
Beginning Investment Date									
Date(s) Recorded	High	Low	Closing	High	Low	Closing	High	Low	Closing
1.									
2.									
3.									
4.									
5.									
Low for Period ▶									
High for Period ▶									
1st Day Closing ▶									
2nd Day Closing ▶									

Calculate your profit or loss by figuring the difference of the price of your share of stock at the closing price of the first reading and the closing price when you sold the stock.

Profit or Loss ▶			

(2C) Secondary Processes

Manufacturing

Assembly Line, an activity supporting the Production Processes concept, is designed for approximately 2 class periods.

Resources Needed

Equipment

48 identical ball point pens
Stop watch
Assorted storage boxes and parts bins

Objectives

The student will

understand why an assembly line is used;
experience the stress in an unorganized situation; and
develop an orderly way of assembling an object.

Evaluation Focus

☐ Knowledge	☒ Problem Solving	☒ Attitude
☒ Awareness	☐ Machine/Tool Usage	

Assembly Line

Procedure

1. Set out the 48 pens, assembled and in a storage box.

2. Instruct the students to gather around. Upon a given signal, the students are to take a pen, take it apart, and throw all parts into a large cardboard container. Time this activity and record the time.

3. Reorganize the class. Instruct the students that they are to reassemble the pens as quickly as possible after a given signal. Time this activity and record.

   Note: Students probably will be very disorganized and will tend to compete with each other for parts and positions. Some students may get angry and frustrated to a point where they leave the activity. However, let the activity continue.

4. After the pens are assembled and the time recorded, reorganize the students. Discuss the results. Ask questions such as:

   How many ended up with too many of one part?

   How many couldn't find a needed part?

   How many quit before the entire task was finished? Why? (Be careful not to make the students defensive with this question. Let them know it was a "natural" reaction to the situation.)

   How did you feel about this exercise?
   (Possible answers: I thought it was fun. I hated it. I got hurt. I got mad. Someone kept stealing my parts, etc.)

   What was wrong?
   (Possible answers: Too many people. Couldn't get the part I needed. We weren't organized.)

   How would you like to work this way for eight hours?

5. For your final question, ask:

   How can we improve on this method of assembly?

6. From this point on let the *students* develop a variety of assembly lines. Time and record these to see which method is most efficient. Some possible solutions include:

   Have students line up and take off a part and pass the rest on. Reverse this for assembly process.

   Have students each pick up a pen and take it apart as they walk past the bins. Reverse this process for assembly.

   Split the group, and do two assembly lines.

   Place more students at the most difficult jobs.

Assembly Line

Name _____

Class/Period _____

1. Why was it frustrating to reassemble the pens when each of you worked alone?

2. How did working together improve the process?

3. You developed several assembly lines. What seemed to work best? Why?

4. If you had to develop an assembly line for building toasters, what things did you learn with the pen assembly line that would help you?

(2C) Secondary Processes

Manufacturing

Candle Holder, an activity supporting the Production Processes concept, is designed for approximately 4 to 5 class periods.

Resources Needed

Equipment

Enameling oven
Hydraulic press
Blanking die
Hydroformer
Explosion forming die
Spinning lathe
Spinning chuck
Spin forming tool
Drill press
Pop rivet gun
Standard tools (center punch, ball peen hammer, drill bits, pliers, screwdrivers, files)

Materials

3" x 3" aluminum sheet
3" x 3" copper sheet
Steel wool (00)
Enameling compound
.22-caliber power loads
Spinning wax
Clear spray finish
Rivets
Candles
Vinegar

Source

Some of these resources are available from

Parks Adventuras Projects
805 South Devonshire
Springfield, MD 65802
Phone: (417) 883-0427 or (417) 836-5157

Demonstrations Needed

Safe use of all tools and equipment
Processing techniques and sequence

Objectives

The student will

learn to use standard tools and equipment;
learn to use various not-so-standard tools and equipment;
understand shop techniques as part of overall material processes; and
process copper and aluminum disks into a finished candle holder.

Evaluation Focus

☐ Knowledge	☐ Problem Solving	☐ Attitude
☐ Awareness	☒ Machine/Tool Usage	

Candle Holder

Procedure

In this activity, you will process standard materials, copper and aluminum sheets, into a useful product. By completing this activity, you will get a better understanding of the many processes required to make a product. You will also use many different tools and types of equipment. By using modern industrial materials, tools, and processes, you will gain a better understanding of manufacturing technology.

Processes are activities that change materials according to a specific plan. Sawing, drilling, sanding, grinding, bending, and painting are some of the more common methods (specific ways) of changing materials into products. These processes can be classified into four general categories: forming, combining, separating, and finishing. You will be performing a number of material processes. When doing a particular process, try to classify it into one of these four general categories.

Before starting this activity, your instructor will show you the location of the equipment that you will be using. Your instructor will also show you a number of demonstrations on how to use the equipment safely. (**Note:** Pay close attention to these demonstrations.)

Separating Process

The first process you will perform is a separating process. Separating is done to change the shape of material by removing some of it. Separating is done in a number of different ways. You are going to separate some of your material by shearing.

When shearing, a piece of the material is cut away from the rest of the material. For example, cutting a piece of paper is shearing. Sheet metal and plastic are often sheared. In the following procedure, you will use a blanking die to shear your sheet metal into a round shape.

▶ Caution

The machines should be used only with your instructor's permission and/or presence.

1. Figure 1 shows the blanking die. Get one and take it to the hydraulic press.

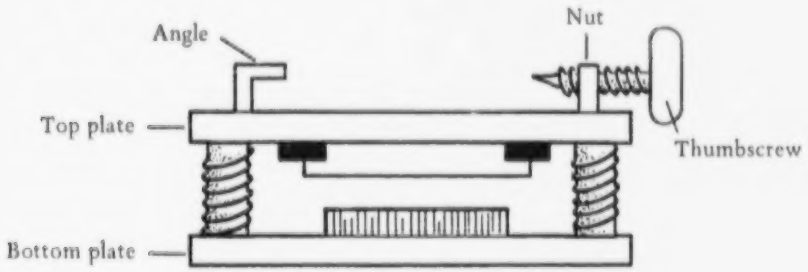


Figure 1

2. The blanking die has an angle and a nut welded to it. There is a thumbscrew in the nut. Locate these parts. Also, identify the top and bottom plates.

3. Mount the blanking die at the top of the hydraulic press using the following steps.

   A. Hook the angle on the back of the press as shown in Figure 2. The top of the press is shown in cross section.

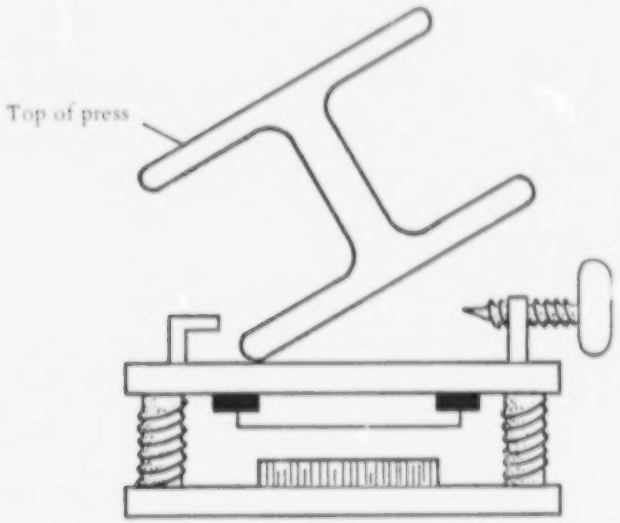


Figure 2

   B. Pull the thumbscrew end up and toward you until the angle hooks on the back of the press as shown in Figure 3.

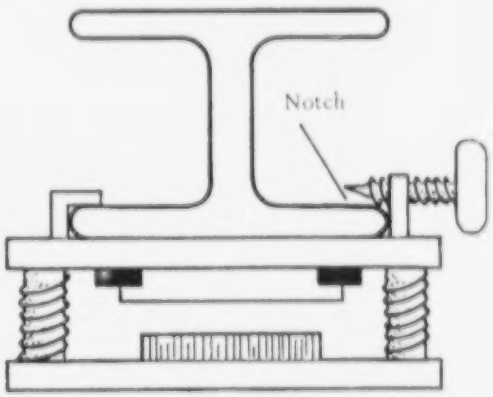


Figure 3

C. There is a small notch on the front of the press. Move the blanking die sideways until the notch and the thumbscrew are in line.

D. Tighten the thumbscrew. The pointed end of the thumbscrew should go in the notch.

4. Unscrew the jackscrew in the top of the hydraulic jack so it sticks up about two inches.

5. Place the copper piece in the die between the top and bottom plates.

6. There are two small pins on the bottom part of the die. One is on the back and the other is on your left. Position the copper against both pins.

7. Use the jack handle to raise the jack until you hear a "popping" sound. After the sound, move the jack up one more full stroke of the jack handle. The copper must be kept against both pins while applying pressure.

8. Release the jack pressure until the jack no longer touches the blanking die.

9. Remove the copper part from the blanking die.

10. Repeat Steps 5 through 9 using the aluminum piece.

11. Save the discs. Put the scraps in the salvage boxes.

12. Lower the jack as far as it will go.

13. Loosen the thumbscrew on the blanking die. Remove the blanking die and put it away.

Forming Processes

You are going to form your aluminum piece, using a forming process called "hydroforming." Equipment used in this process will press the aluminum blank between two pieces of harder metal (steel). This will stretch the aluminum to its required shape. (Additional forming will be done to the aluminum piece later.)

14. Figure 4 shows a hydroformer. Get one and take it to the hydraulic press.

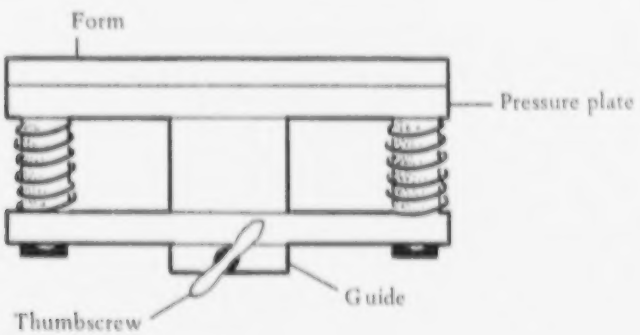


Figure 4

15. The jackscrew on the hydraulic press must be screwed out one inch or more. (**Note:** Check to see that it is screwed out one or two inches.)

16. Figure 4 identifies the parts of the hydroformer. Identify the thumbscrew, guide, form, and pressure plate.

17. Remove the form from the hydroformer and set it aside.

18. Place the guide over the jackscrew and tighten the thumbscrew. (It may be necessary to first loosen the thumbscrew to get it to fit over the jackscrew. Have the side with the thumbscrew toward you.)

19. There are two small guide pins on top of the pressure plates. These serve as stops for the work and guide pins for the form. Put the *aluminum* on the top of the pressure plate and push it against both pins. (**Note:** Your *copper* blank does not get formed by this process.)

20. Put the form on top of the *aluminum*. There are two guide holes in it that must go over the guide pins. The unpainted side of the form must be down.

21. Apply pressure.

22. Lower the jack.

23. Remove the form.

24. Remove the part from the form. If it does not come out easily, slide a tool under the edge of the part and gently pry it loose. Try not to scratch the aluminum. (**Note:** If the formed part is torn or hard to remove, have your instructor apply a heavy coat of spinning wax to the bottom side of the form and the top side of the pressure plate.)

25. Remove hydroformer. Put it away.

Another type of forming process will be used to form your *copper* blank; it is called explosion forming. Explosion forming is like hydroforming in that both processes stretch the metal into shape. With explosion forming, however, the pressure from an explosive charge, rather than a hydraulic press, is used to stretch the metal.

▶ Caution

You will be using a .22-caliber explosive charge during this process. It has the potential to be very dangerous. Follow your instructor's directions exactly.

26. Get the explosion former. See Figure 5.

27. There are two doors on the former, with a catch to keep them closed. See Figure 5. Loosen the catch and open both doors.

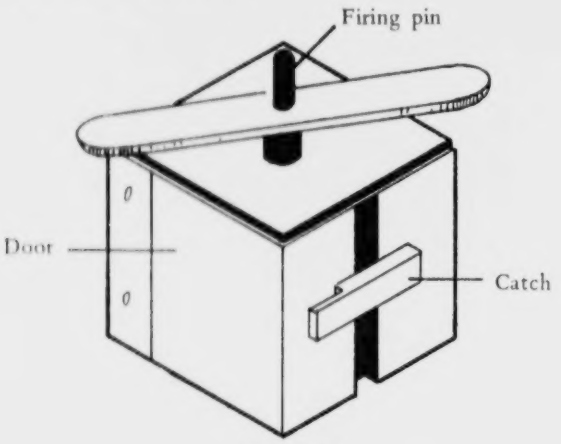


Figure 5

28. Loosen the retaining bolt enough to remove the explosion chamber. See Figure 6. (The doors are not shown in this figure.)

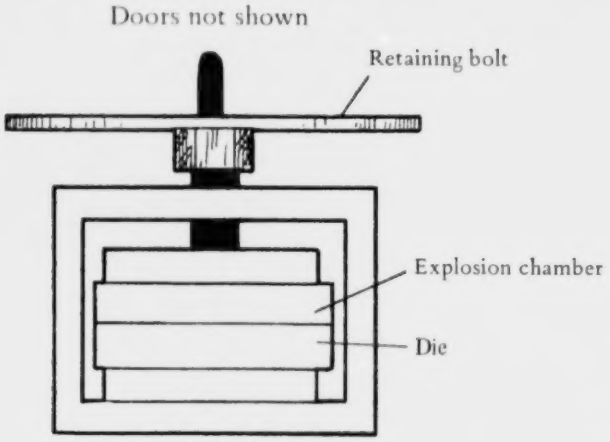


Figure 6

29. Obtain a .22-caliber power load from the instructor.

30. There is a large hole with straight sides in the top of the explosion chamber. At the bottom of the hole is a smaller hole. Push the power load into the small hole. (**Note:** Do not pound on it.)

31. Place the copper disk on the die. Figure 6 shows the die.

32. Place the explosion chamber on top of the disk.

33. Tighten the retaining bolt. The bolt must go into the 3/4-inch hole in the explosion chamber. (**Note:** Keep the disk centered on the die, and tighten it as tight as you can.)

34. Close the doors. Fasten the catch.

35. Gently tap the firing pin with a press handle. See Figure 5. You should hear an explosion. If you do not, gently tap it again. (**Note:** Do not hit it hard.) If it does not fire, consult the instructor before going on to the next step.

36. Loosen the catch and open the door.

37. Loosen the retaining bolt. Remove the explosion chambers and the copper disk.

38. A rod is chained to the explosion former. Use it to push the power load casing out of the explosion chamber. See Figure 7.

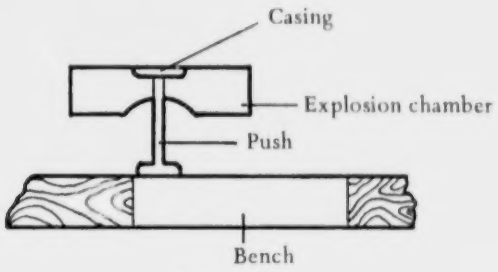


Figure 7

39. Give the used power load to the instructor.

40. Reassemble the explosion former. Put it and the hammer away.

The next process you are going to do will be drilling. Can you determine what type of material process "drilling" is? (Remember the four general categories are forming, separating, combining, and finishing.)

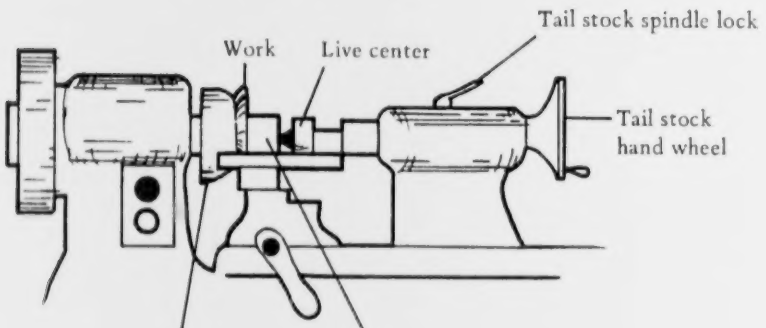
41. There is a small depression (dent, punch mark) at the center of the aluminum and copper pieces you just formed. These are called "drill spots." A drill spot is used to locate the center of a hole to be drilled.

42. Using a plier to hold the pieces and a block of wood under the metal, drill a hole in the center of each piece. Remove the burrs with a large drill bit by hand.

Spinning is another forming process. You will continue forming your aluminum blank to its final shape by spinning. The blank is pressed over a wood form (called a chuck) while it rotates or spins on a lathe.

43. Have the teacher set up the lathe for spinning. Figures 8 and 9 show the proper setup.

Figure 8
Side view of spinning lathe



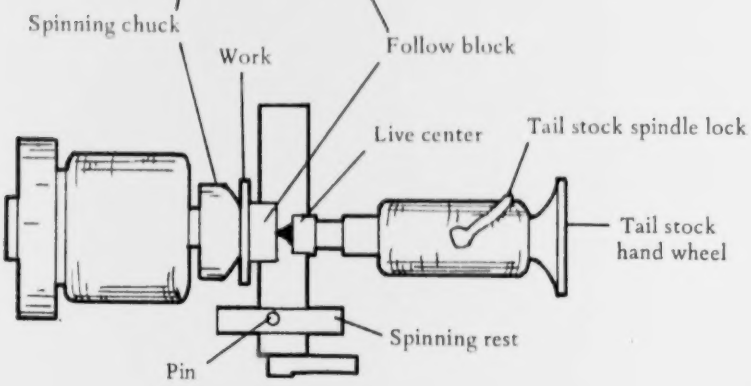


Figure 9
Top view of spinning lathe

A. Your work goes between the spinning chuck and the follow block. The formed part fits over the chuck. The recess in the follow block fits over the work, and the outer rim of the follow block will press the work onto the proper position when the tailstock is tightened.

B. The live center goes into the small hole in the follow block.

C. The tail stock should be positioned so the spindle can move in or out about one inch.

D. Lock the tail stock spindle.

E. Have the spinning rest about 1" below center (if possible).

F. The pin in the spinning rest should be about one inch to the right of the work.

G. The spinning rest should be about one inch away from the work. Turn the work to be sure it does not hit the rest.

H. Have the pin in the rest about one inch to the right of the work.

I. Adjust the revolutions per minute (rpm's) for about 1,000 rpm's, if adjustable.

▶ Caution

Do not proceed until your instructor has checked your setup.

The machine should be turned on and operated only with your instructor's permission and/or presence.

44. Wipe a little spinning wax on the pointed end of the spinning tool.

45. Start the machine.

46. (**Note:** Once you start this step, it must be done very quickly.) Put the spinning tool to the left of the pin against the follow block and the work. Hold on to the end of the handle and quickly push the point hard against the follow block and the handle to your right. This should form the aluminum to the spinning chuck. (If this isn't done quickly, the aluminum may get hard and not spin properly.)

47. Stop the machine and inspect the work. The aluminum should be formed against the spinning chuck.

48. Repeat Steps 45 and 46 as needed.

49. Loosen tail stock spindle lock. See Figure 8.

50. Remove the follow block from the work and the piece from the lathe.

Combining/Finishing Processes

51. While holding them with a rag or paper towel, use steel wool on all surfaces of the formed aluminum and copper.

52. Spray both sides of the aluminum piece with clear finish (hold spray can 10 inches away). This is a finishing process; the clear finish will keep your aluminum part from tarnishing.

The next step, enameling, is really a combining and a finishing process. It is a combining process because two or more materials are being put together. It is a finishing process because a coating will be applied to your copper material for protection and decoration. What will happen to the copper if it is not protected from the atmosphere?

53. Polish the convex side of the copper with steel wool.

54. Place a wire hook in the hole and submerse the copper in a cleaning solution of vinegar and water. Move it around in the solution.

55. After removing it from the solution, rinse in water and then dry with a paper towel. (**Note:** Do not touch the piece with anything but the paper towel.)

56. Place the copper, convex side up, on a wire rack on a piece of paper, and shade the enameling material on the surface until it is completely covered and no copper shows through.

57. Set up the heat source and place the copper piece into the heat source until the enamel melts. This will be about 300 degrees F.

> **Caution**
>
> Do not touch the metal with your bare hands. It will be hot enough to cause severe burns.

58. Remove the piece from the heater and set aside to cool.

59. If you are the last one to use the heat source, unplug it and clean up the area.

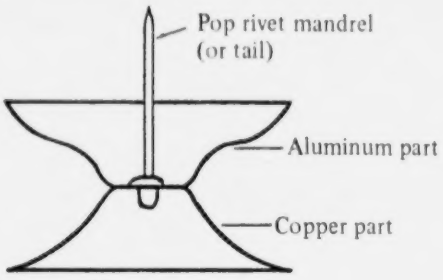
60. Return all enamel material to the correct container.

61. Return all materials to the instructor.

The final material process you will be doing in this activity will be another combining process. You will be fastening the copper and aluminum parts together by using a mechanical fastener called a pop rivet. Some more common mechanical fasteners include screws, nails, nuts, and bolts. No matter what type, all mechanical fasteners depend on friction to hold parts together.

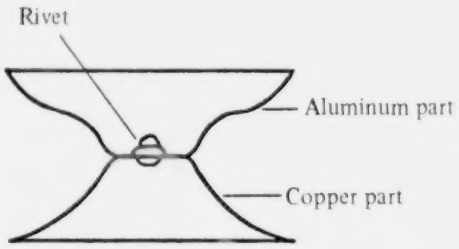
62. Get a 1/8-inch pop rivet and the pop rivet tool.

63. Use the pop rivet to fasten the copper to the aluminum as shown in Figures 9 and 10. The rivet goes through the holes punched in the two parts from the aluminum side.



Assembly of parts before popping the rivet

Figure 9



Finished assembly

Figure 10

64. Place candle in holder. Push down on the candle and twist it two or three times to properly seat it.

▶ Caution

Matches should be lit only with your instructor's permission and/or presence.

A fire extinguisher should be nearby when open flames are used.

65. Borrow another candle. Light it and drop melted wax around the base of your candle. This will hold your candle in place.

66. Put the flame out and return the borrowed candle.

(2C) Secondary Processes

Manufacturing

Determining Wood Moisture Content, an activity supporting the Production Processes concept, is designed for approximately 1 class period.

Resources Needed

Equipment
Two-point moisture content instrument

Materials
Samples of various species of wood in different drying stages

Objectives

The student will
learn how to determine wood moisture content in various species of wood by testing three different samples; and
become familiar with different variables that affect moisture content.

Evaluation Focus

☒ Knowledge	☐ Problem Solving	☐ Attitude
☐ Awareness	☒ Machine/Tool Usage	

Determining Wood Moisture Content

Procedure

The amount of moisture in lumber seriously affects how it can be used. Lumber that has too much moisture cannot be used for fine cabinet or furniture manufacturing. As the wood dries out, it will change shape (warp, shrink, bow, etc.) and cause close tolerance joints to shift, come apart, or look unpleasant. Before any wood can be used in a manufacturing process, it must be tested to see if it can be safely used. Wood that is too wet can be left to dry longer, or it can be rejected and sent back to the supplier.

In this activity, you will learn how to use a two-point moisture content instrument and its accompanying tables to determine the moisture content of various samples of woods. Study the "Temperature Correction Table" and the "Wood Species Table" that come with the instrument. You will need to use both of them to determine the correct figure.

Meter Adjustment

1. Begin adjustment of the moisture meter by holding down the button labeled "adjust" and turning the knob until the needle on the dial lines up on "ADJ." or "20" (be accurate).

2. Let go of the button.

3. Now, hold down the adjust button again and check your reading. Is it still correct? If not, go back to Step 1 and adjust again. If yes, continue on to the next step.

Testing A Wood Specimen

4. Remove the plastic protective cap from the contact pins of the electrode.

5. Test the wood specimen.

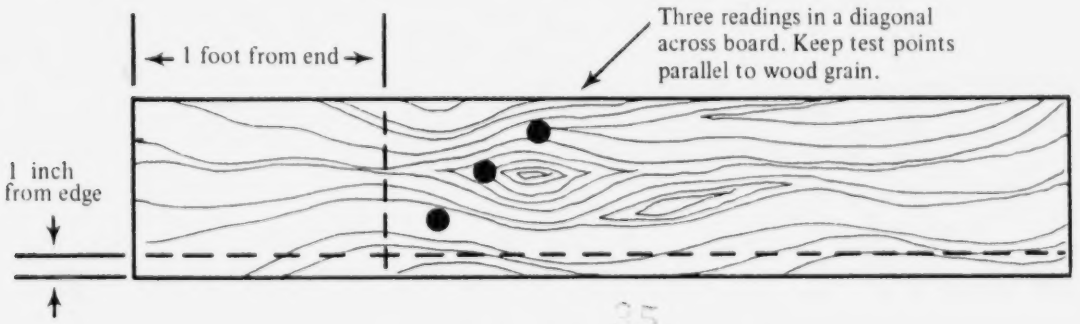
   A. Drive the contact pins into the wood one-fifth of the thickness of the wood.

   B. Make the test at least 1' from the end of the board.

   C. Be sure you are at least 1" from the edge of the board.

   D. Keep the contact pins parallel to the grain of the wood.

   E. Take three readings diagonally across the board.



6. The correct reading will be the average of the three readings, but first corrections for temperature and wood species must be made in the raw data.

Reading Correction

7. Take one of your readings and go to the "Temperature Correction Table." Correct your reading by looking at the left-hand column for wood temperature (approximately the same as room temperature). Find your temperature and follow horizontally across the table until you find your meter reading. Add or subtract the listed number from your reading. For example:

   wood temperature = 80° F
   meter reading = 20%
   temperature correction = -1
   temperature-corrected reading = 19%

8. Using the "temperature-corrected reading," go to the "Wood Species Table" to complete the correction. Find the wood species in the left column, and again follow across horizontally until you find the vertical column for your temperature-corrected reading. (For help, see example at the bottom of the "Wood Species Table".)

9. Make the indicated correction on your temperature-corrected reading of 19%.

   temperature-corrected reading = 19%
   wood species = hickory
   hickory at 19% - 2.6% [average of -2.4(18) and -2.8(20)]
   final reading of 19% – 2.6% = 16.4%

   Thus, the first moisture content reading of hickory, after corrections, is 16.4%.

10. Follow the same procedure for the other two readings, so that you have three corrected readings (adjusted for temperature and species).

11. Finally, average the three readings for each board tested. The average will be the correct figure for the moisture of the wood.

12. Complete the first page of the Student Response Sheet by performing tests on various wood species at varied stages of drying.

Determining Wood Moisture Content

Name _____

Class/Period _____

Moisture Content Test Data Sheet				
Wood Species	**Original Reading**	**Temperature Correction**	**Species Correction**	**Final Reading**
	1.	1.	1.	1.
	2.	2.	2.	2.
	3.	3.	3.	3.
	Average of Three Readings ▸			
	Moisture Content ▸			

Moisture Content Test Data Sheet				
Wood Species	**Original Reading**	**Temperature Correction**	**Species Correction**	**Final Reading**
	1.	1.	1.	1.
	2.	2.	2.	2.
	3.	3.	3.	3.
	Average of Three Readings ▸			
	Moisture Content ▸			

Moisture Content Test Data Sheet				
Wood Species	**Original Reading**	**Temperature Correction**	**Species Correction**	**Final Reading**
	1.	1.	1.	1.
	2.	2.	2.	2.
	3.	3.	3.	3.
	Average of Three Readings ▸			
	Moisture Content ▸			

(2C) Secondary Processes

Manufacturing

Jig and Fixture Design, an activity supporting the Production Processes concept, is designed for approximately 5 to 7 class periods.

Resources Needed

Equipment

Handsaws, table saws, band saw
Drill press

Materials

Scrap wood
Plywood
Vellum drafting paper
Variety of fasteners

Objectives

The student will

solve a design problem;
produce a finished drawing of the design; and
construct the product designed.

Evaluation Focus

☐ Knowledge	☒ Problem Solving	☐ Attitude
☐ Awareness	☐ Machine/Tool Usage	

Jig and Fixture Design

Procedure

The success of any automated production system depends largely on quality jigs and fixtures. Good jigs and fixtures are characterized by several key features—accuracy (meets specified tolerances), repeatability, durability, safety, ease of operation, and speed. A poorly designed and/or built jig and fixture can cause unpleasant problems for a manufacturer, such as excess waste, injury, poor quality, and loss of valuable work time. Learning to design good tooling requires creativity and practice. This activity should stretch your imagination and help acquaint you with some of the problems associated with designing jigs and fixtures.

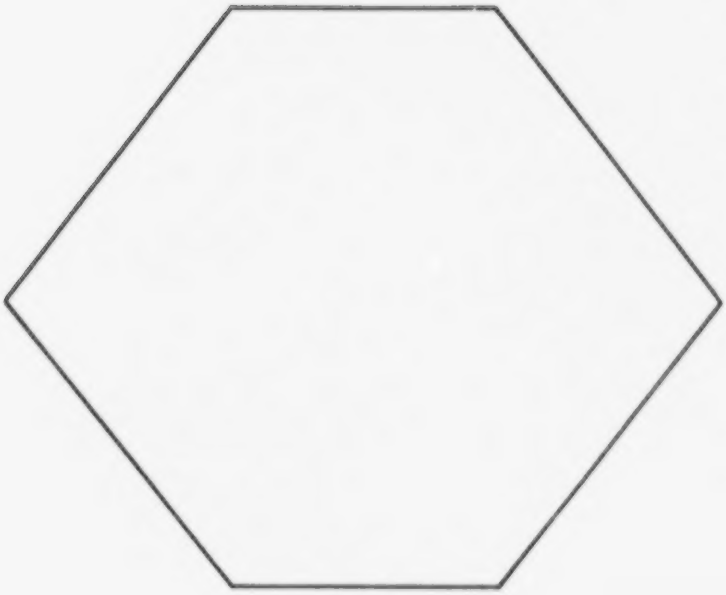
1. Select *one* of the following problems.
2. Brainstorm tools, operations, etc., that could produce the design.
3. Select the tool (or machine) your jig is to be designed for.
4. Brainstorm possible jig or fixture designs.
5. Complete rough sketch of jig and/or fixture.
6. Evaluate design with instructor.
7. Make working drawings according to the following guidelines:

   show orthographically;
   show dimensions of all parts;
   label drawing;
   outline clamps used;
   draw full scale, if possible.

8. Evaluate drawings with instructor.
9. Redesign, if necessary.
10. Build and test.

▶ Caution

The machines should be operated only with your instructor's permission and/or presence.

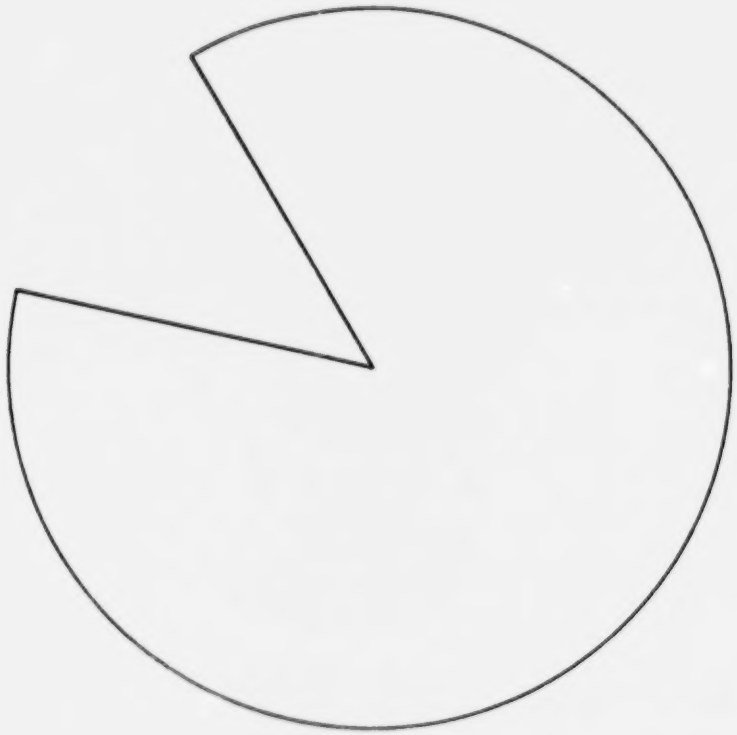


This piece will be cut from a 4" x 4" piece of masonite. Design so there is as little waste as possible.

You are responsible for all cutting operations.

Tolerance on all dimensions is 1/16".

The above is a full-size drawing of your part. Dimensions can be read with a ruler.



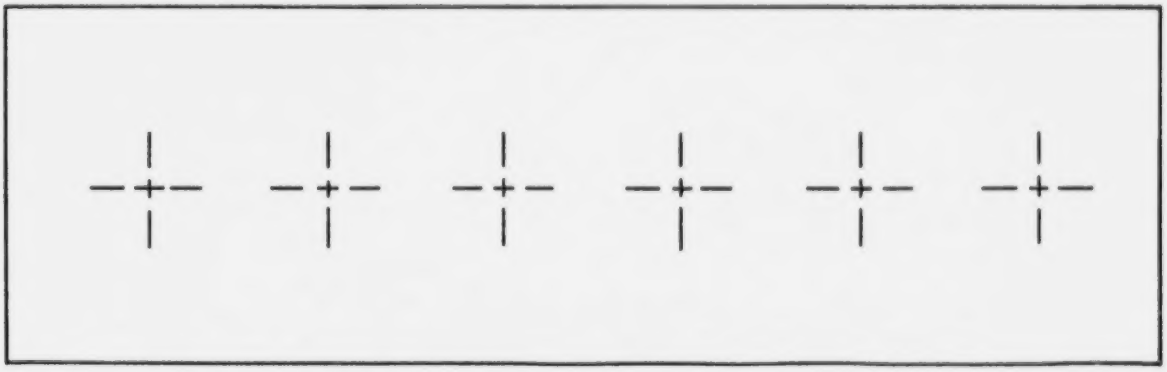
This piece will be cut from a 4" x 4" piece of masonite.

Design so there is as little waste as possible.

You are responsible for all cutting operations.

Tolerance on all dimensions is 1/16".

The above is a full-size drawing of your part. Dimensions can be read with a ruler.

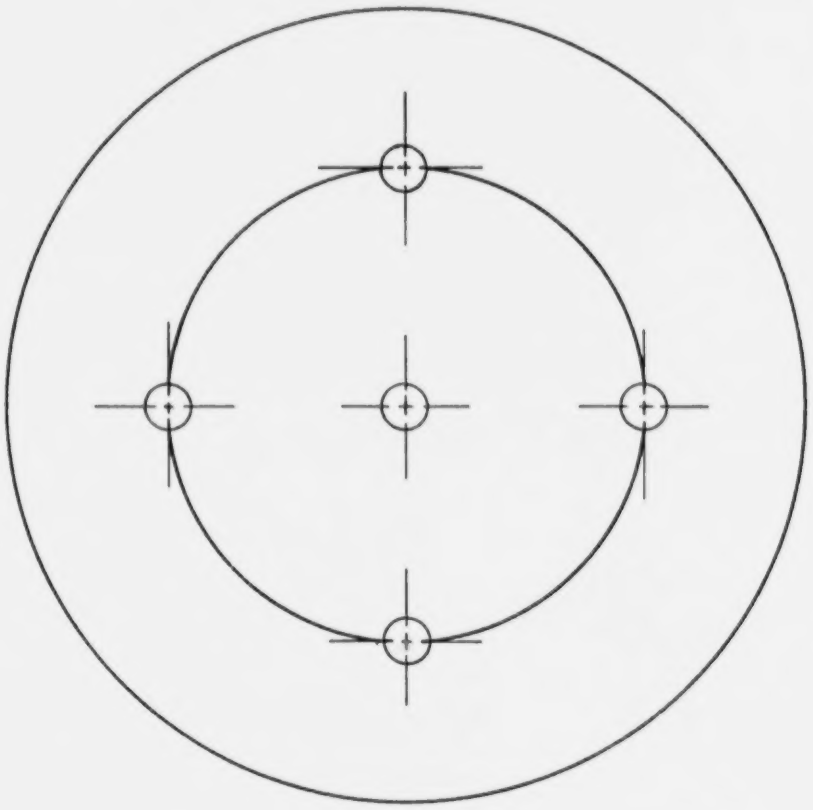


The above is a full-size drawing of your part. Dimensions can be read with a ruler.

Holes must be drilled with a 1/4" drill bit.

Tolerance is 1/16".

You are responsible for all drilling operations.



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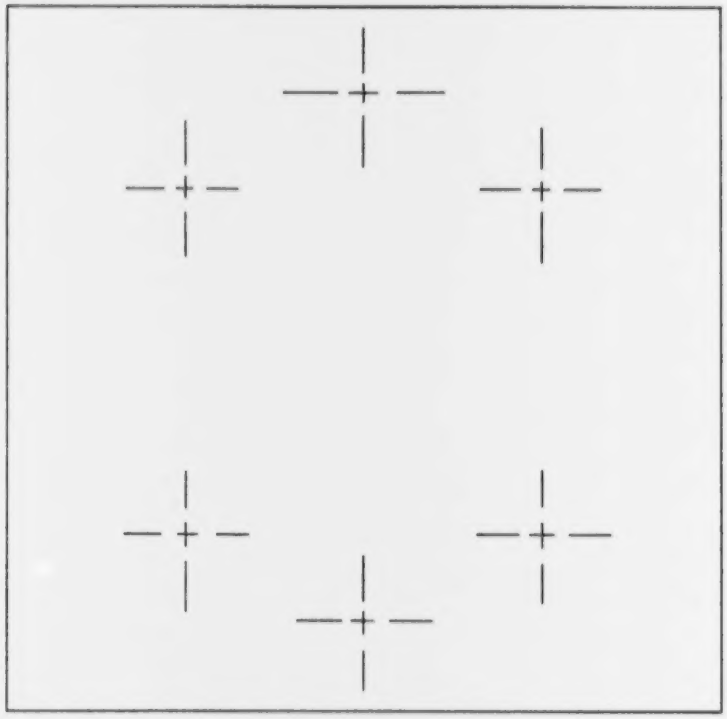
Tolerance is 1/16".

You are responsible for all drilling operations.



The above is a full-size drawing of your part. Dimensions can be read with a ruler.

Holes must be drilled with a 1/4" drill bit.

Tolerance is 1/16".

You are responsible for all drilling operations.

(2C) Secondary Processes

Manufacturing

Parallel Jaw Clamp, an activity supporting the Production Processes concept, is designed for approximately 15 class periods.

Resources Needed

Equipment

Wood working equipment
Wire feed welder
Metal lathe
Milling machine
Gas welder
Cutting torch
27/64" drill bit
Tap and die, 1/2" diameter, 13 NC

Materials

1/2" round cold rolled steel
1" round cold rolled steel
Hard wood
1/4" x 2" flat steel
Plastisol
Aluminum
Varnish
Glue
Stain

Objectives

The student will

use a variety of materials and the major secondary manufacturing processes of molding, forming, separating, conditioning, assembling, and finishing;
solve problems in design and planning; and
construct a parallel jaw clamp.

Instructor's Options

The students can work alone or in a group of two or three.

The students can be given the basic drawing, showing overall dimensions, and they can be asked to develop their own design and specific dimensions. The basic dimensions given in this activity can be used, or they can be changed as desired. There are several ways to make the jaws open and close. Students can be asked to devise their own method.

A flow chart diagram could be required for planning parts construction.

Evaluation Focus

- ☒ Knowledge
- ☐ Awareness
- ☐ Problem Solving
- ☒ Machine/Tool Usage
- ☐ Attitude

Parallel Jaw Clamp

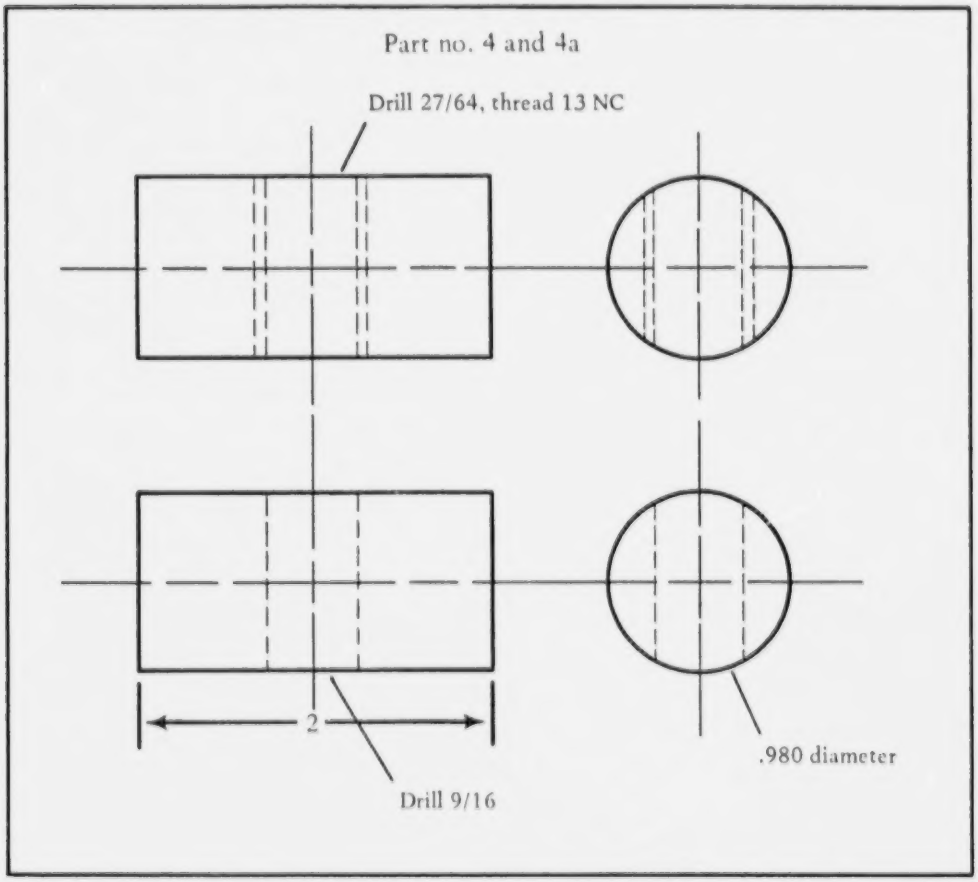
Procedure

▶ Caution

The machines should be operated only with your instructor's permission and/or presence.

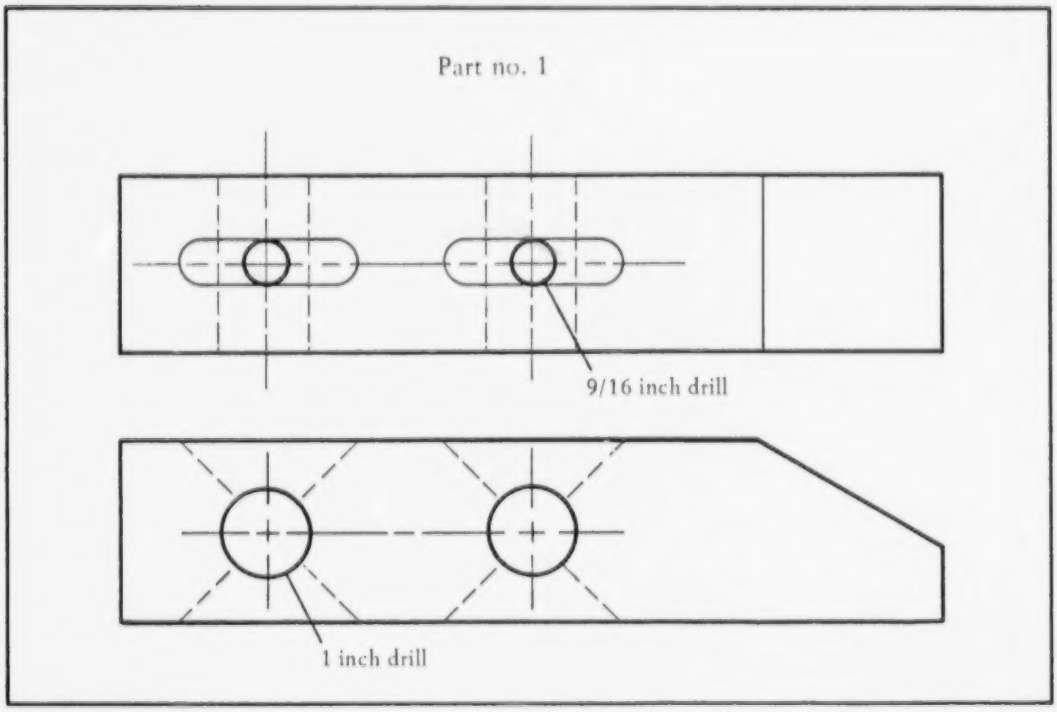
Rod Supports (Part Nos. 4 and 4a)

1. Cut a piece of 1" round stock 9" long.
2. Face, center drill, and mount between centers on metal lathe.
3. Turn the rod down to .980". Use the micrometer to check this dimension.
4. Cut the stock into four 2" pieces, and drill a 27/64" hole in the center of two of the pieces.
5. Drill a 9/16" hole in the other two pieces.



Jaw (Part No. 1)

1. Glue and clamp rough dimension stock together for jaws.
2. Lay out and measure length and width.
3. Cut to size on table saw.
4. Lay out angle for the end of the jaw and cut on the band saw.
5. Drill two side holes 1" in diameter after laying out their proper location.
6. Drill 9/16" holes in the top and the bottom that line up with the center of the 1" holes.
7. File the 9/16" holes at a slight angle so that the clamp can move more freely.
8. Sand, stain, and finish.



Handles (Part No. 3)

1. Using the cut-off tool on the metal lathe, cut two 1" x 4" pieces of round stock.

2. Face both ends and mount the piece between centers and knurl (this allows the plastisol to hold better).

3. Center drill a 27/64" hole 1" deep.

4. Tap out the hole with a 13 NC tap.

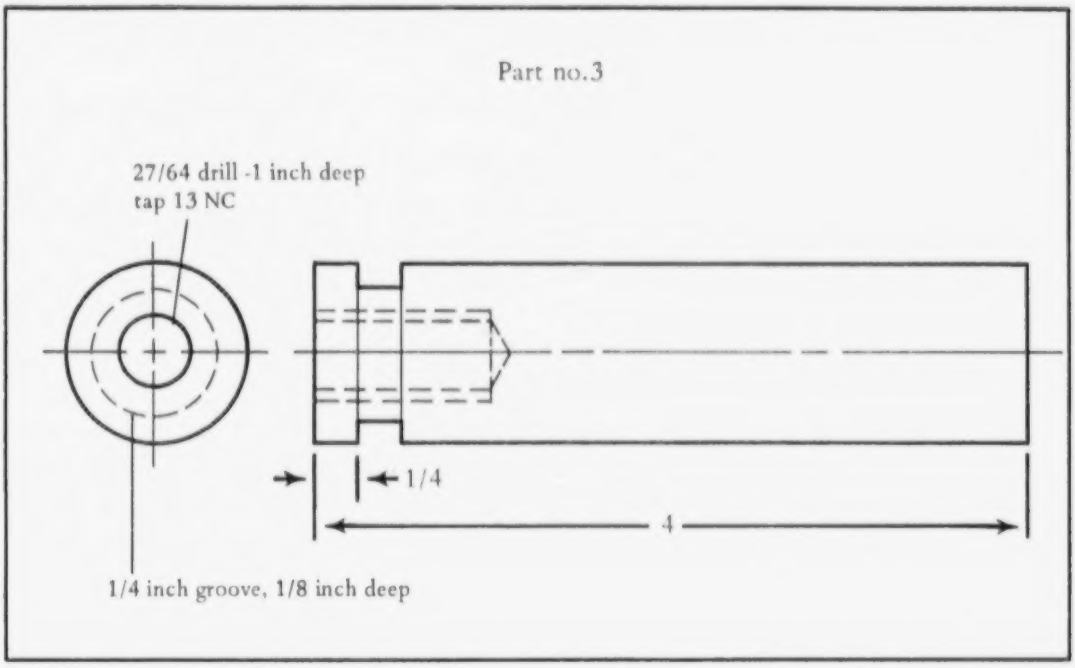
5. Using the cut-off tool, make a 1/4" notch 1/2" up from the threaded hole end.

6. Put in plastics oven; heat to 450° F and then coat the handles with plastisol. Do the process again if a thicker coating is needed.

> **Caution**
>
> Do not touch the metal with your bare hands. It will be hot enough to cause severe burns.

7. Wire feed weld the handles to the threaded rod.

8. Option—the handle may be cast out of alumimun to allow exploration in a molding process and in using aluminum material in a casting.



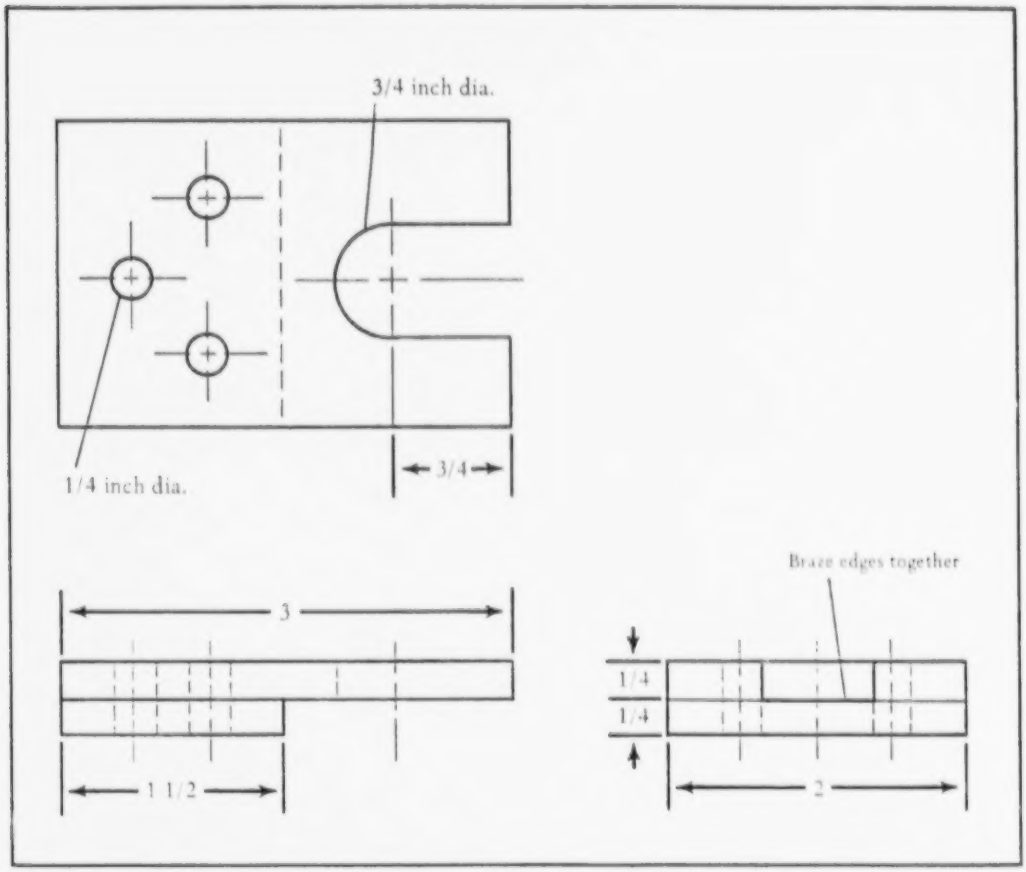
Handle Locks (Not shown in assembly view.) (The cutting torch can be used for a different separating process.)

▶ Caution

The cutting torch should be used only with your instructor's permission and/or presence.

If it is used, a fire extinguisher should be nearby.

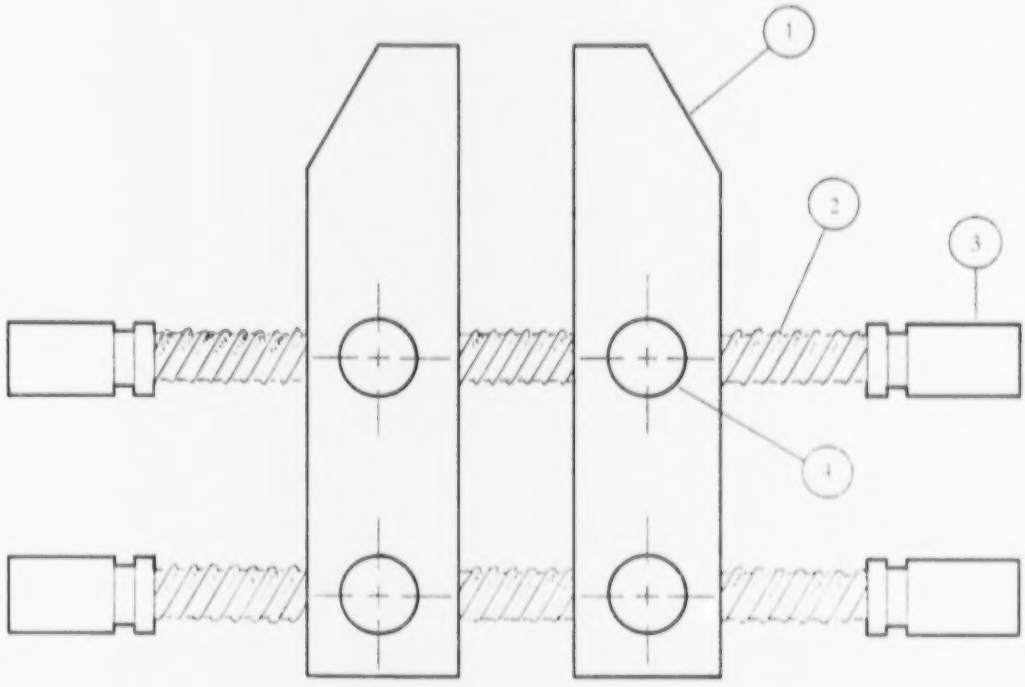
1. Cut two pieces of 1/4" thick metal 2" x 3".
2. Cut two pieces of 1/4" thick metal 1-1/2" x 2".
3. Braze the shorter piece under the larger piece.
4. Drill a 3/4" hole, 3/4" back from the front.
5. File and buff for a finished surface.
6. Drill three attaching holes in the back portion. These will be used to attach the handle locks to the saw.



Threaded Rod (Part No. 2)

1. Using the hacksaw, cut two 14" length 1/2" rods.
2. Slightly taper one end on the grinder to receive the die.
3. Place one end in the vise and, using a 13 NC die, turn the threads 12" down the rod.
4. Cut the excess 2" off the rod.

Clamp Assembly View
(with part numbers labelled)



(2C) Secondary Processes

Manufacturing

Producing a Stepladder, an activity supporting the Production Processes concept, is designed for approximately 25 class periods.

Resources Needed

Equipment/Materials are specified in the Bill of Materials and detailed assembly instructions.

Objectives

The student will

work at different positions of an assembly line;
produce many of the same part for the stepladder; and
meet quality control specifications.

Instructor's Note

This activity for the mass production of a stepladder can be the core activity of a six- to nine-week unit on enterprise. The enterprise experience involves students in organizing a company to produce a product. Several textbooks are available that describe this total process. One to consider is: James Fales and Everett Sheets. *Manufacturing*. Bloomington, IL: McKnight Publishing Co., 1983.

This activity assumes prior instruction about the nature of the enterprise, basic material processing procedures, and safety and production techniques. This activity packet includes the technical material to facilitate the production of a stepladder as the product of the enterprise. A series of forms useful in the operation of this activity or any other teacher-directed manufacturing simulation is included elsewhere in this activity book.

Complete the assembly by having each student write a short summary comparing working individually to being part of an assembly line and indicating which they prefer.

Evaluation Focus

- [x] Knowledge
- [ ] Awareness
- [ ] Problem Solving
- [x] Machine/Tool Usage
- [x] Attitude

Producing a Stepladder

Procedure

This is both a production and an assembly activity. Working alone, you will make the major parts of a common stepladder. The class will then be formed into assembly lines to produce the wood and metal braces needed to complete assembly. Detailed instructions and drawings are given. In addition, assembly flowcharts are also provided. Study these materials carefully and follow the directions step by step. Check anything you don't understand with your instructor.

Individual Production

Bill of Materials

Name of Part	Qty.	Rough Size	Qty.	Finished Size
Step	2	1" x 4" x 13-1/2"	2	3/4" x 3-1/2" x 13"
Large leg	2	1" x 4" x 22"	2	3/4" x 3-1/2" x 22"
Brace	2	1" x 1" x 22"	2	3/4" x 3/4" x 22"
Small leg	1	1" x 4" x 22"	2	3/4" x 2" x 21"
Top	1	1" x 6" x 15"	1	3/4" x 5-1/2" x 14-1/2"
Leg block	1	1" x 4" x 20"	2	1-1/2" x 3-1/2" x 5"

Top and Steps

1. From a piece of 1" x 6" x 15", cut the top to finished size. Follow the squaring steps.

2. Stamp your class number in the edge of the board.

3. From the pieces of 1" x 4" x 13-1/2", cut the two steps to finished size. Follow the squaring steps.

4. Stamp your class number in the edges of the boards.

5. On both steps and top, rout a "V" groove in the better face. Use the "V" groove bit on the table router with a fence. Set the bit so it cuts 1/8" deep and 1" away from the edges.

6. On the *top* use the round-over bit in the table router and round both *edges* and *ends* of the better face (the same face that the "V" groove is in).

7. On the *steps*, use the round-over bit in the table router and round *only* the *two edges* of the better face (the same face that the "V" groove is in).

8. Your steps are now ready for sanding.

Large Legs/Small Legs

1. From a piece of 1" x 4" x 22", cut the large legs to finished size. Follow the squaring steps. (**Note:** Finished length = Rough length, keep ends square for now—this will change in Step 5.)

2. Stamp your class number in the edge of the board.

3. Lay out the dado cuts on the large legs and also the angular cuts on the ends. (First lay out one leg and have your teacher *check your layout*; then lay out second leg.)

4. Have your teacher *check your layout*.

5. Cut the angled ends of the large legs on the table saw. Make sure to set the miter gauge to the correct angle.

6. Cut the dado cuts on the large legs using the jig on the radial arm saw. Make sure the depth of the saw and the placement of the jig is correct *before* you start cutting.

7. From a piece of 1" x 4" x 22", cut the small legs to finished size. Follow the squaring steps.

8. Stamp your class number in the edge of the board.

9. Shape one end of the small leg to a semi-circle. (Find the center of the leg, set the divider to this distance, and draw a semicircle. Cut this on the band saw.)

10. With the drill press, drill a 1/4" diameter hole in the semicircle end. The center of the hole will be the same point that was used for making the semicircle end. (**Note:** Keep the other end of the small leg square.)

11. Your large and small legs are now ready for sanding.

Leg Block

1. With the planer, surface one face of the 1" x 4" x 20" so it is smooth and level.

2. Cut the long piece into two equal lengths.

3. Glue the two together, face to face. Make sure you put the planed surfaces together.

4. Use the pattern and mark the shape. Cut this on the band saw and sand smooth.

5. With the drill press, drill a 1/4" hole through the leg block. Use the pattern for hole location and make sure the arrows are flush.

6. Your leg block is now ready for sanding.

Braces–Wood and Metal

The wood braces will be made by several students using a mass-production method. The metal braces will be made by the entire class using a mass-production technique. After this is done and the finished braces are available for you, go on to the next section and assemble your stepladder.

Trial Assembly

1. Sand all pieces with 120 grit using the orbital sander.
2. The first step is to assemble the steps to the large legs.
   A. On the large legs, label the top and bottom.
   B. On the steps, label top step and bottom step.
   C. *Center* steps on the large leg.
   D. Use #8 x 1-1/2" flat-head wood screws–two on each step. Assemble steps to legs.
3. Assemble leg block to the *top* of the large leg.
   A. The top of the large leg should be flush with the top of the leg block.
   B. Use a C-clamp to hold in position.
   C. Use #8 x 1-1/2" flat-head wood screws–two on each side.
4. Attach the small legs to the leg blocks with 1/4" diameter, 2-1/2" long round-head machine screw. (**Note:** Bolt head on outside–washer and nut on inside.)
5. Fasten the top to the leg blocks.
   A. *Center* the top on the leg blocks.
   B. Use #8 x 1-1/2" flat-head wood screws–two on each side.
6. Locate the center of the wooden braces and drill a 3/16" diameter hole through.
7. Fasten the braces together with a 3/16" bolt.
   A. Bolt head on outside–washer and nut on inside.
   B. Set the braces to a 90° angle.
   C. Mark the braces with a pencil.
   D. Tighten bolt to prevent braces from moving.

8. Attach the braces to the small legs.

   A. Measure 3" up from square end and draw line with square.

   B. Center the brace on the small legs.

   C. Make sure small legs are parallel to large legs.

   D. Mark the location of the lower brace as it crosses the leg.

   E. Cut in with a back saw and remove wood with chisel so that *one* brace fits flush with small leg.

   F. Sand small legs and wooden braces with 120 and 220 grit sandpaper.

   G. Use #8 x 1" flat-head wood screws to attach brace leg.

   H. Use a back saw to cut the brace close to the leg.

   I. Use some abrasive paper and sanding block to make the brace and leg fit flush.

9. Mount the metal leg braces to large and small legs.

   A. Draw a line down the center of the small and large legs.

   B. Adjust the legs so they make a 70° angle with the floor.

   C. Mount the brace so that it is parallel to steps.

   D. Drill a 3/32" pilot hole about 1/2" deep with portable electric drill.

   E. Use a #8 x 3/4" round-head wood screw.

10. Use a 24" bench rule and mark the angle on the small leg. Use saber saw to cut the angle on the small leg.

11. Disassemble the steps, large legs, leg blocks, and top. Leave the small legs and wooden brace together.

12. Sand all parts with 220 grit paper. Have the teacher *check your sanding.*

13. Reassemble the steps, large legs, leg blocks, and top.

Finishing

1. You may stain your project or leave it the natural color.

2. Apply two coats of oil finish.

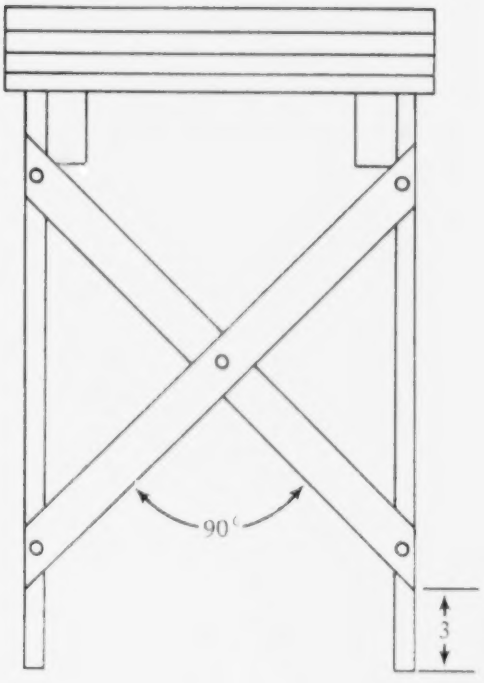
3. Buff with paste wax and steel wool.

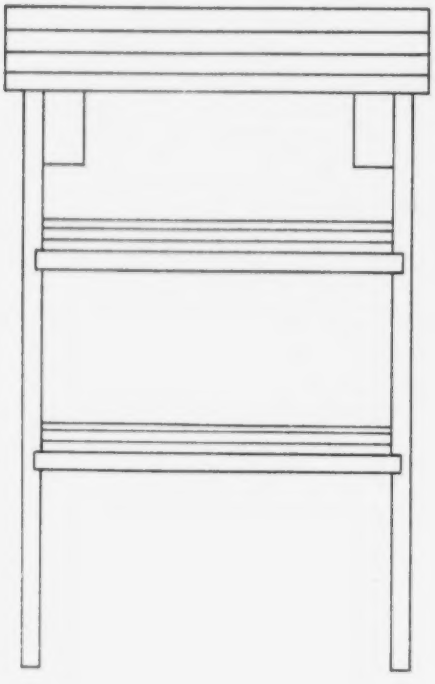
4. Assemble small legs and metal brace.

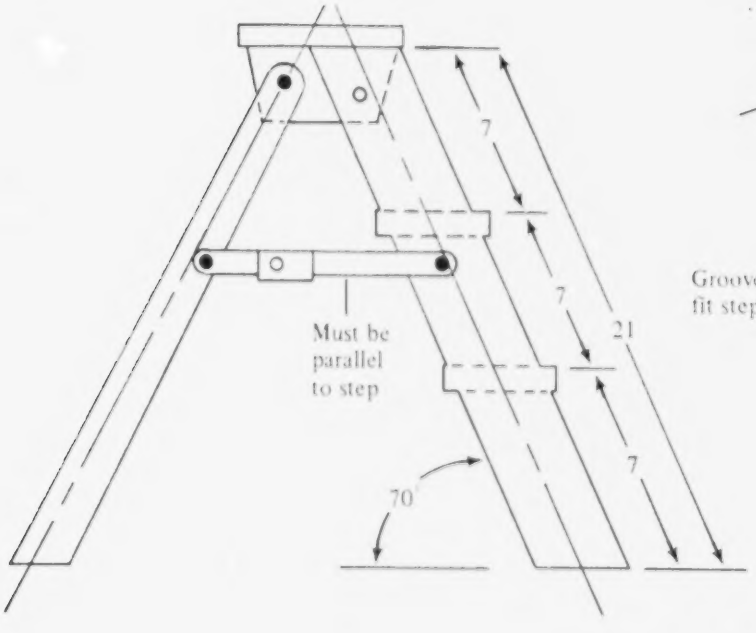
5. Make the project stand level. Use a flat metal table (table saw or spindle sander) to mark the legs of your project.

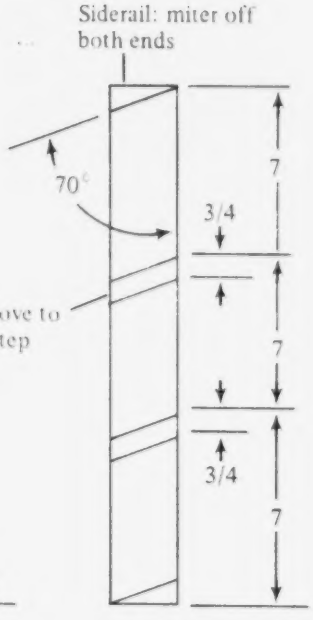
6. Turn your project in for a grade.

Stepladder


90°
3




7
7
21
7
Must be
parallel
to step
70°


Siderail: miter off
both ends
70°
7
3/4
7
Groove to
fit step
7
3/4
7

Mass Production for Stepladder Metal Brace

Note: Job numbers correspond to box numbers on assembly flowchart.

Short Leg 4-1/4"

1. Job: *Cutter*
   Name: _____
   Duty: Use a hand hacksaw with a vise and cut the metal to 4-1/4" long. Use a combination square as a cut-off gauge. Check the combination square so that it does not move.

2. Job: *Filer*
   Name: _____
   Duty: Check metal for correct length (4-1/4"). With a vise and file, remove the burrs from *one* end. Keep this end square.

3. Job: *Grinder*
   Name: _____
   Duty: Check that one end of the metal is filed. On the other end, round this over using the grinder.

4. Job: *Drill Press Operator*
   Name: _____
   Duty: Check round end and square end. Drill a 3/16" diameter hole in the *square end*. Use oil and drill two at a time. Use the pattern to locate the hole.

5. Job: *Drill Press Operator*
   Name: _____
   Duty: Check that the square end has a hole in it. Drill a 9/64" diameter hole in the round end. Use oil and drill two at a time. Use the pattern to locate the hole.

6. Job: *Filer*
   Name: _____
   Duty: Check that the metal has the correct size hole in each end. File the burrs left from drilling. Clean the metal with alcohol.

7. Job: *Inspector*
   Name: _____
   Duty: Check that the square end has a 3/16" diameter hole, the round end has a 9/64" diameter hole, and that there are no burrs and no oil on the metal. Count completed pieces and bring to assembly area.

Long Leg—5-1/2"

8. Job: *Cutter*
   Name: _____
   Duty: Use a hand hacksaw with a vise and cut the metal to 5-1/2" long. Use a combination square as a cut-off gauge. Check the combination square so that it does not move.

9. Job: *Filer*
   Name: _____
   Duty: Check metal for correct length (5-1/2"). With a vise and file, remove the burrs from both ends. Keep these ends square.

10. Job: *Drill Press Operator*
    Name: _____
    Duty: Check the ends for burrs. Drill a 3/16" diameter hole in the one end. Use oil and drill two at a time. Use the pattern to locate the hole.

11. Job: *Drill Press Operator*
    Name: _____
    Duty: Check that the other end of the metal has a hole in it. Drill a 9/64" diameter hole in the other end. Use oil and drill two at a time. Use the pattern to locate the hole.

12. Job: *Filer*
    Name: _____
    Duty: Check that the metal has the correct size holes in each end. File the burrs left from drilling. Clean the metal with alcohol.

13. Job: *Inspector*
    Name: _____
    Duty: Check that one end has a 3/16" diameter hole, the 9/64" diameter hole is 3/4" from the end of the metal, and that there are no burrs and no oil on the metal. Count completed pieces and bring to assembly area.

Sheet Metal Clip

14. Job: *Squaring Shear Operator*
    Name: _____
    Duty: Cut the galvanized metal to 1-1/2" long by 1-1/4" wide.

15. Job: *Punch Operator*
    Name: _____
    Duty: Check that the metal is the correct size (1-1/2" x 1-1/4"). With a template and a Whitney punch, punch the first hole in the metal. Insert a rivet in the first hole, then punch the second hole.

16. Job: *Bar Folder Operator*
Name: _____
Duty: Check that the two holes are punched in the metal. Insert piece into bar folder and bend to a 90° angle. Make sure piece is square to bar folder. Machine setting: 90° stop; 31/64" depth gauge.

17. Job: *Filer*
Name: _____
Duty: Check that the two holes line up on clip. Remove the sharp corners from the clip with a file.

18. Job: *Inspector*
Name: _____
Duty: Check that the two holes line up, sharp corners removed, bent to correct angle. Count finished pieces and bring to assembly area.

Assembly of Braces

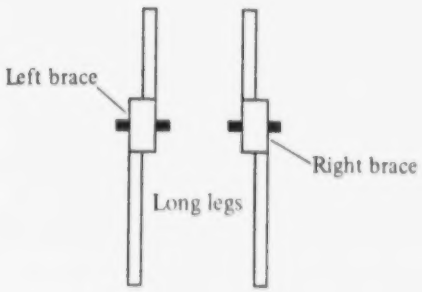
19. Job: *Assembler*
Name: _____
Duty: Insert one short leg and one long leg into the metal clip. *Both* the long and short legs *must* have the small hole (9/64" diameter) in the clip. Insert a rivet and flatten the rivet on the anvil.

20. Job: *Off-Set Bender*
Name: _____
Duty: Check that the holes on the end of the brace are large (3/16" diameter). Take a pair of braces and arrange so that the long legs are together. Put the long leg of the right brace in a vise and insert the jig *exactly* as shown. Turn the vise closed. Next, put the short leg of the right brace in the vise and insert jig *exactly* as shown. Turn the vise closed. Now do the same for the left brace but *reverse* the position of the jig. This will complete a pair of braces.

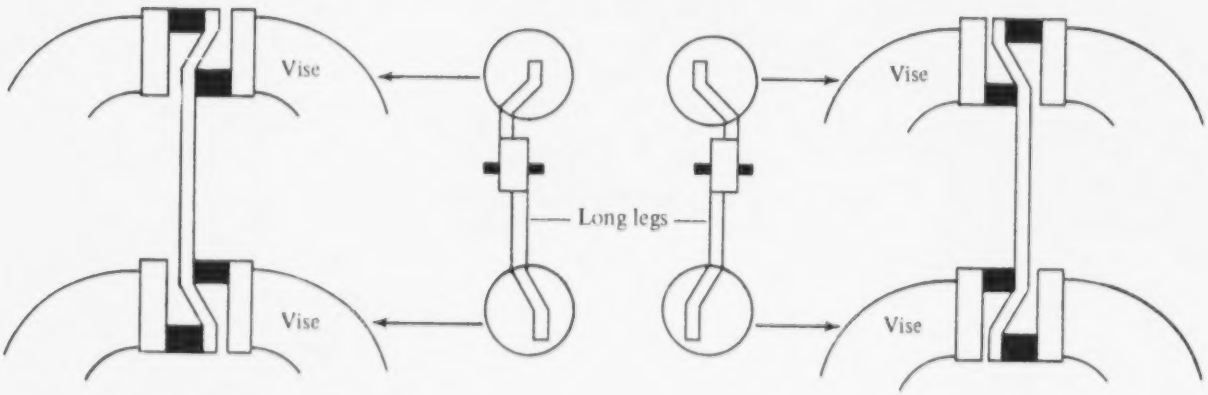
21. Job: *Inspector*
Name: _____
Duty: Check that the pair of braces is made correctly (large hole in ends of brace, one left and one right brace, the offset bend is correct, the metal is clean). Count the pairs and bring to paint area.

22. Job: *Painter*
Name: _____
Duty: Slightly bend both braces and put together on a paper towel. Spray paint one side and set aside to dry. After first side is dry, turn braces over and paint second side. When finished, wrap the pair of braces in a paper towel.

Pair of braces

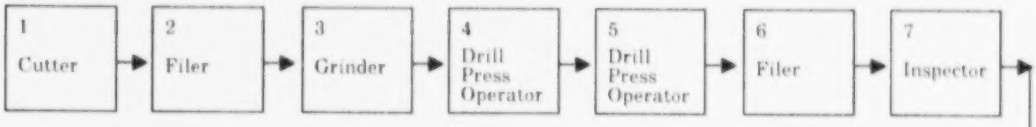


Offset bends in pair of braces

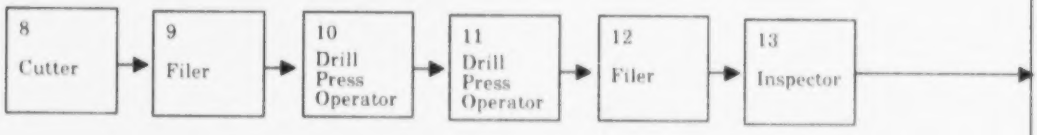


Flowchart for Stepladder Metal Brace

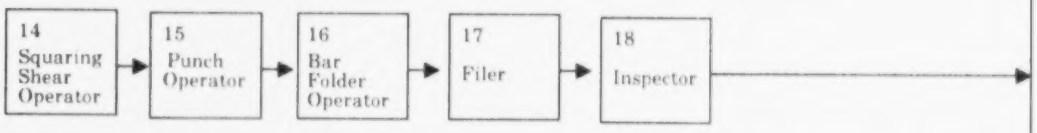
Short Leg



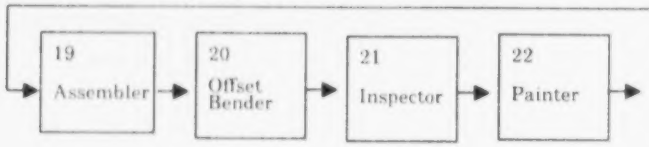
Long Leg



Sheet Metal Clip



Assembly of Braces



(2C) Secondary Processes

Manufacturing

Sawdust Recycling, an activity supporting the Production Processes concept, is designed for approximately 3 to 4 class periods.

Resources Needed

Equipment

Molds available from
Industrial Arts Supply Company
5724 W. 36th Street
Minneapolis, MN 55416

Materials

Safety glasses
Paper cups (4- and 8-ounce sizes)
Polyester resin
Catalyst
Releasing agent (wax or silicone spray)
Acetone
Stir sticks (from scrap)
Rags or paper towels
Shop aprons or coats

Objectives

The student will

study wood waste reuse;
learn one method of recycling wood waste; and
recycle sawdust into a useful product.

Evaluation Focus

☒ Knowledge
☐ Awareness
☐ Problem Solving
☐ Machine/Tool Usage
☒ Attitude

Sawdust Recycling

Procedure

As the human population on the earth increases, the materials used by people also increase. Many of these materials are thrown away when people are finished with them. Several methods are used to get rid of used materials, including burning, burying in landfills, and recycling. Recycling is simply the reuse of what was once considered waste. Recycling is a way of using some of these materials several times.

With recycling, not only can materials be reused, but new materials do not have to be taken from the earth. Several tons of iron are required to make the steel for an automobile. Less iron ore is needed if scrap metal is used in place of some of the new metal.

When newspapers have been read, they are usually thrown away, and drink cans are thrown away once they have been emptied. Both of these materials are easy to recycle and use again. Recycling paper means fewer trees have to be cut, and when aluminum is recycled, bauxite ore is saved. But, more importantly, energy is saved. It takes large amounts of energy to make aluminum. Much less energy is needed to melt aluminum for reuse.

The wood processing industry creates considerable amounts of wood waste each year. Most of this waste is in the form of sawdust that is gathered in "dust collectors." In this activity, you will learn how to recycle this waste material into a useful product, and you will learn about other products that are made from sawdust.

The total amount of wood waste created by the wood-working industry exceeds 15 million tons per year—enough to make a pile 50 feet high, 100 feet wide, and more than 150 miles long. There are 20.8 cubic feet of wood waste for every 1,000 board feet of lumber cut. Most of this waste is created by saw mills.

There are four major categories of wood waste reuse.

Uses based on special physical properties. Examples of products that use sawdust because of its special physical properties are liquid spill clean-up materials (the sawdust absorbs the liquid), floor coverings, sweeping compounds, metal polishes, and lightweight cement aggregate (which helps hold glue together).

Fuel uses. Sawdust is most often used as fuel by conversion into logs in "press-a-log" machines.

Fiber- and wood-base boards. Examples of products that fall into this category are particle board, roofing felts, paper, and building fiberboards.

Chemical uses. Some of the sawdust is used to reclaim the chemicals that constitute wood. Through distillation (refining a material by heating and then gathering the vapors given off), various usable chemicals can be obtained from sawdust, such as turpentine and alcohol.

In this activity, you are going to recycle sawdust into a useful product, using a die, resin, and chemical hardener. It is suggested that the mold for this activity be a one-piece open die. This activity will require assistance from the instructor due to its many variables (die shape, temperature, age of the resin, and amount of hardener used). These are some suggestions to keep in mind:

Aerosol paintable silicone mold release works better than paste wax and gives a smoother finish.

The thinner the mold, the more hardener is needed and the more brittle it becomes. As the mold thickens, the hardener required decreases rapidly due to the chemical reaction temperature.

Below is a chart that seems to work.

Mold Thickness	Resin	Hardener
1/8 inch	8 oz.	40–60 drops
1/4 to 1/2 inch	8 oz.	25–35 drops
3/4 inch and up	8 oz.	20–25 drops

If you are using a two-piece die, these suggestions may be helpful:

Let the mixture stand in the bottom of the die until the air bubbles come to the surface (about five minutes).

Next, carefully put the top of the die (or mold) over the bottom and press down until you can just see the mold on a level surface. Do not clamp the die together.

▶ Caution

Wear safety glasses. The hardener used in this activity can cause irreversible eye damage or blindness. The polyester resin can cause extreme eye irritation. Do not touch your face with your hands when using these chemicals.

Wear an apron or shop coat. If resin gets on your clothes, it will not come out.

1. Use a mold or die to form the resin/sawdust mixture.

2. You will need to apply wax or a silicone spray to the mold or die. This is called a releasing agent. The releasing agent allows the mold to come apart (release) after the resin/sawdust mixture hardens. If a releasing agent is not applied to the mold, it will be firmly stuck together when the resin hardens, making it difficult for you to get your molded object out.

3. Obtain from your instructor the amounts of resin and hardener needed for your mold. Amounts will vary with the size and thickness of the mold.

4. Measure polyester resin needed and pour it into a large paper cup.

5. Add the catalyst.

6. Mix the polyester resin and catalyst together thoroughly. If you do not mix this well, the solution will never harden. The catalyst causes a chemical reaction with the resin, which changes it into a solid material called plastic.

7. **Note:** A binder material is any material that can hold another material together. Polyester resin is the binder material used in this activity. The sawdust is the material that needs to be held together. (Another binder material is wax, which is used to hold wood waste together for making fireplace logs. The sawdust then can be used as fuel.)

8. Slowly add an equal amount of sawdust to the resin. It should be completely absorbed by the resin. Mix the sawdust into the resin until it turns dark brown and there are no dry flakes of sawdust left. (The sawdust is being used as a reinforcing material and a filler material. It makes the project stronger and less expensive. A filler material is any material that is used to take up a required amount of space. A reinforcing material is any material combined with another to make an object stronger.)

   For example, when polyester resin is used as a binder and glass fibers are used as a reinforcing material, the mixture of these two materials is called fiberglass. Fiberglass is a lightweight, strong plastic material frequently used in many products, such as boat hulls, car bodies, toys, and fishing rods. The Chevrolet Corvette has a body made of fiberglass (polyester, glass-fiber-reinforced resin.)

9. Pour the sawdust and resin mixture from the paper cup into the mold. Spread the sawdust resin mixture evenly throughout the inside of the mold. Have your instructor check to make sure you have done this correctly.

10. Put the mold on a level surface and allow the mixture to cure overnight.

11. Clean up the work area. Wipe up any drips of resin with paper towels. Discard the paper towels and any stirring sticks in an appropriate waste container with a lid.

▶ Caution

Do not wash your hands with water yet.

12. If your hands are sticky from the resin, they will need to be cleaned with acetone. Dampen a paper towel with acetone, and rub it on your hands. (Acetone is a solution that dissolves polyester resin. It removes polyester resin from your hands and equipment much like paint thinner removes oil-base paint from a paint brush.)

13. After your mold cures overnight, take the project out and sand or file the rough edges.

14. Turn the molded polyester resin/sawdust product into your instructor.

15. Answer the questions on the Student Response Sheet.

Sawdust Recycling

Name _____

Class/Period _____

1. What is the reason for waxing all parts of the die before you begin?

2. What is the purpose of a hardener?

3. What is a catalyst? What purpose does it serve in this project?

4. Are a hardener and a catalyst one and the same?

5. What is binder material?

6. What type of binder material is being used in this activity?

7. List two other common binders.

8. What is filler material?

9. Give two examples of filler material.

10. What is reinforcing material?

11. Give an example of a reinforcing material.

12. Wax comes in different forms (liquid and solid), and it can be used for different purposes. Earlier in this activity, it was used as a releasing agent, and it was said that it can be used as a binding agent for fireplace logs. How else is wax used? Give at least two answers.

13. Is there much wood waste in the woodworking industry? How much?

14. What are four areas where wood waste is reused?

15. How does sawdust react with a liquid, and why is it used to clean up liquid spills?

16. What is the common name for polyester, glass-fiber-reinforced resin? What are four common products made from this material?

17. Polyester resin is a _____ material when used for recycling sawdust. It _____ the sawdust together to make a useful product.

18. What is recycling?

19. What liquid solution is used to clean up tools and equipment after use with polyester resin?

(2C) Secondary Processes

Manufacturing

Single-Barrel Whistle, an activity supporting the Production Processes concept, is designed for approximately 3 class periods.

Resources Needed

Materials

Drafting paper
Pine block, 6" x 1" x 1"
Dowel, $\frac{1}{4}$" x 1"
No-lead paint

Equipment

Drill press
Band saw
Wood burner

Objectives

The student will

learn how reeds work; and
cut out a single-barrel whistle.

Evaluation Focus

☒ Knowledge
☐ Awareness
☐ Problem Solving
☒ Machine/Tool Usage
☐ Attitude

Single-Barrel Whistle

Introduction

This is a three-day activity that is an excellent project for a change of pace. If the students do a good job of researching and designing, they will have whistles that sound great.

Each student receives a 1" x 1" x 6" piece of pine and constructs the ¼" hole and reed by themselves. Plugs (reeds) for whistle are ¼" dowels ripped at varying thicknesses to allow for pitch of sound. Cut dowels to approximately 1".

After they have completed that, ask if they would like to drill holes in the top to change the pitch of the sound as the whistle is blown. Brainstorm with them about what might happen if more than one hole is added to the top.

(**Note:** It is a good idea to give a demonstration on the drill press and have students put an identification mark or design on the whistles so they do not become mixed up with the others in the class; use *no-lead* paint or a wood burner to do so. Periodically check students as they cut the whistles out, and stress the importance of proper planning and layout to minimize waste.)

Procedure

1. Lead a group discussion on the art of making wood wind instruments and the skill and proper planning that it requires.

2. Check sketches for conformity to overall dimensions as given in the detail drawing.

3. Put sketches onto drafting paper, checking for accuracy.

4. Keep students enthused during entire process and aware of research and development of a product before production.

5. Put drafting sketches onto wood blocks and prepare to cut out.

6. Cut out shape and add design with paint or wood burning or leave plain.

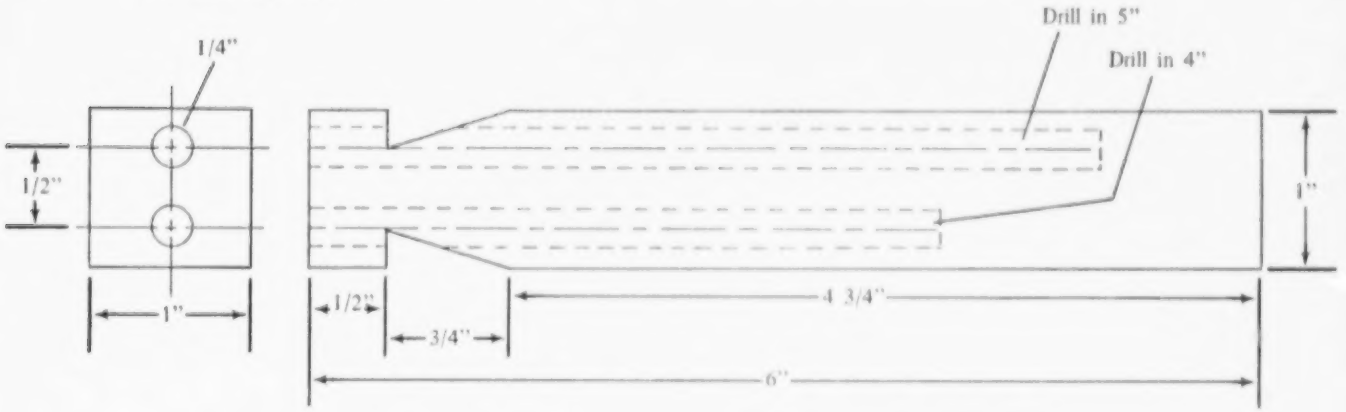
7. Have students blow into whistles to demonstrate the quality of sound (pitch) and if they constructed them with more than one hole. (The class could vote on which sound had the best quality and/or which whistle had the best design.)

8. After each student is done, discuss why some whistles sounded better than others and how their design made that so.

Single-Barrel Whistle

Procedure

In this activity, you will be learning about how reeds work by constructing a single-barrel whistel out of a block of pine wood and a dowel. Your finished whistle should look like this detailed drawing.



1. Research wind instruments and find out how reeds work. You may want to visit a music store or talk to the school's music teacher or band director.

2. Sketch a design for your whistle on drafting paper.

3. Once it is approved by your instructor, transfer your layout to a 1" x 1" x 6" pine block.

4. Cut out your design with the band saw and drill press.

▶ Caution

The equipment should be operated only with your instructor's permission and/or presence.

5. Using a ripped dowel as your reed, slide it into your whistle, using neither glue nor nails.

6. Paint or wood burn a design on your whistle so you can distinguish it from other whistles.

▶ Caution

The wood burner will be hot enough to cause severe burns. Do not touch its tip.

(3A) Management Functions

Manufacturing

Capacity Requirements Planning, an activity supporting the Managerial Processes concept, is designed for approximately 1 or 2 class periods.

Resources Needed

Equipment

Apple IIE computer system

Materials

Person/Machine Chart Analysis computer software, available from
Wisconsin Technology Education Association
University of Wisconsin-Stout
Menomonie, WI 54751

Note: This activity is one part of a larger system called Manufacturing Resource Planning (MRP). Other software components of the MRP system are available from the same source.

Objectives

The student will

analyze a person/machine process chart;
determine data necessary to operate *Person/Machine Chart Analysis* software;
run the software program;
analyze the printout and draw conclusions concerning person-to-machine capacities on the production floor; and
prepare a written report summarizing conclusions.

Evaluation Focus

- ☒ Knowledge
- ☒ Awareness
- ☒ Problem Solving
- ☐ Machine/Tool Usage
- ☐ Attitude

Capacity Requirements Planning

Procedure

Capacity Requirements Planning, which is part of a Manufacturing Resource Planning (MRP) system, is the evaluation of whether or not a production facility has the ability to meet production. It looks at machinery work stations, machine and personnel operating time, and other means. The MRP system indicates what component items will have to be produced and when in order to meet a production schedule. This output can then be converted into the capacities required to produce these items. Such a conversion results in a machine load, or work load, projection, which can then be compared with available departmental and work station capacities to help answer day-to-day operating questions.

Should we work overtime?
Should we transfer work from one department to another?
Should we hire more people?
Should we subcontract some work?
Should we start a new shift?

Traditionally, the tool used in determining capacity has been the "Load Report." Although a good manual tool, more effective determiners are available in computer software that can analyze many variables at one time. In the activity that follows, you will be using computer software that helps you assess person-to-machine capacities on the production floor.

Person/Machine Charting

Person/machine charting, originally an industrial engineering tool, was borrowed by manufacturing engineers to determine the relationship of person-time to machine-time when one person is asked to operate more than one piece of equipment. The technique is used to answer these questions:

What is the production rate for one person operating two machines?
What is the part cost for one person operating two machines?
What is the utilization for the person and the machine?

An engineer or time-study expert marks off a time-scaled chart to record load, process, and unload time for each of the machines until a repeating pattern develops. Once the pattern develops, the engineer can then determine the total cycle time for a part from each machine. Next, the engineer can calculate remaining data, such as wait-time, utilization, and total parts per hour, and fill in a "Person/Machine Process Chart" for each machine.

Two sample charts are included. Begin by carefully studying the samples. Your first set of computer inputs will be data from these samples. When you understand them, you are ready to use the computer software.

Using Person/Machine Analysis Software

Follow the steps below to operate the software properly.

> **Caution**
>
> The computer should be operated only with your instructor's permission and/or presence.

1. Place the diskette in the drive and turn on the system.

2. Run *Person/Machine Chart Analysis* and wait for the first screen to show.

3. "Do you need instructions? (Y or N)" is seen. Select "Y" if you have never used this software, and read the instructions carefully.

4. Type in the input data required. (**Note:** It is best to have your data ready before starting the program.)

5. Input the data, in the correct sequence, from the Budgeport Mill samples. Given that the cost per hour for the operator is $4.00 and the cost per hour for both machines is $7.00, your input should read:

   Machine 2
   load time .5
   inspect time .5
   unload time .4
   process time 4.0
   cost per hour for operator $4.00

   Machine 1
   load time .5
   inspect time .75
   unload time .35
   process time 4.0
   cost per hour for machine $7.00

6. Once all the data is displayed on the screen, your options are

   to print screen, press (P);
   to continue, press (C); and
   to end, press (E).

7. Print out your response on the printer. Have your instructor check the printout for the computer's analysis. Upon completion of this step, continue with the process problem on the Student Response Sheet.

Sample (Machine 1)
Person/Machine Process Chart

Operation	Mill Keyway Slot
Equipment	Bridgeport Mill #1
Operator	Bill Smith
Analyst	MJJ
Study No.	Sample

	Person		Machine	
	Time	%	Time	%
Work	2.0	38	4.0	76
Idle	3.25	62	1.25	24

Subject Automatic Milling **Date:** 7/1/87

Present / **Proposed** **Dept.** Fabricating **Sheet** 1 of 2 **Chart by** M. Jensen

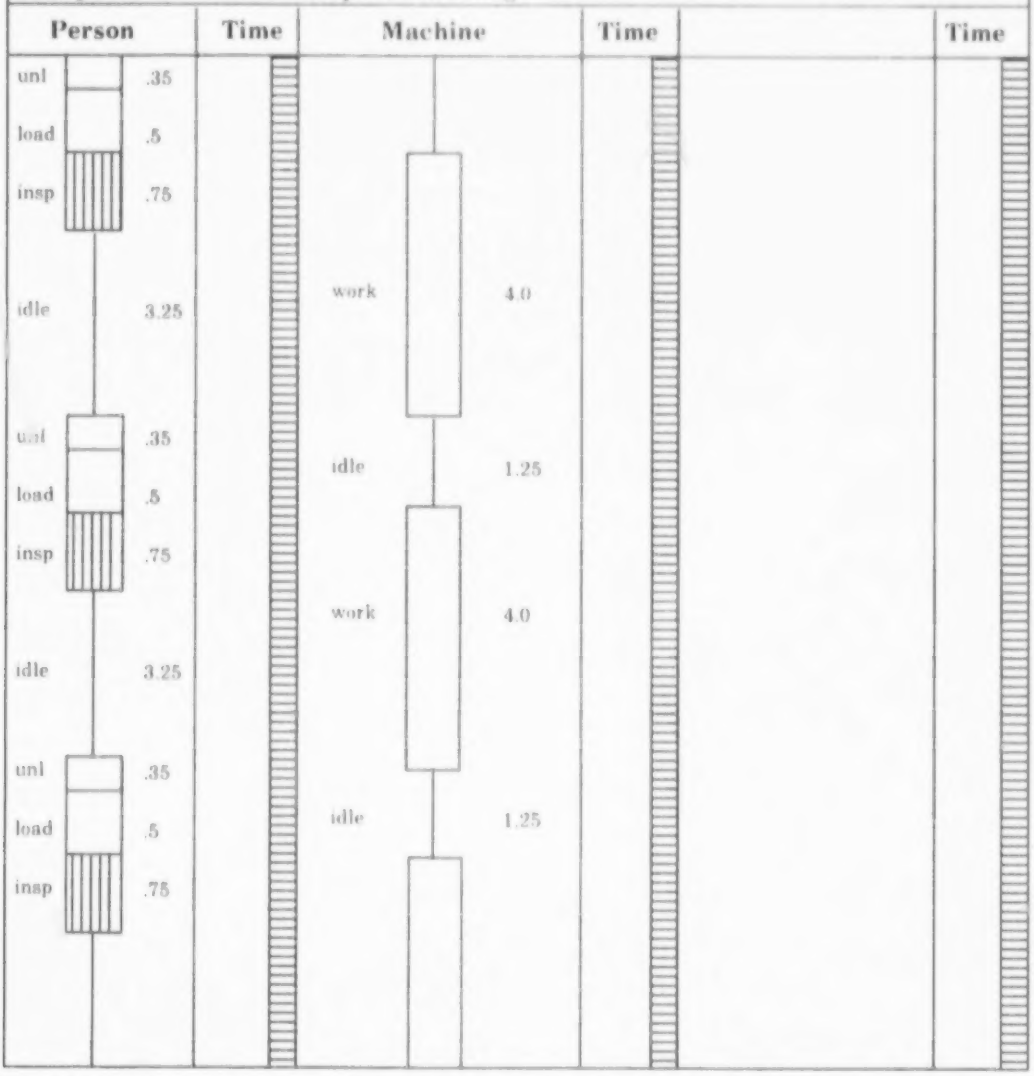


Chart developed by Dr. D. Stallsmith, University of Wisconsin-Stout, Menomonie, WI 54751.

Sample (Machine 2)
Person/Machine Process Chart

Operation	Mill Keyway Slot
Equipment	Bridgeport Mill #2
Operator	Bill Smith
Analyst	M.J.J
Study No.	Sample

	Person		Machine	
	Time	%	Time	%
Work	2.0	38	4.0	76
Idle	3.25	62	1.25	24

Subject Automatic Milling **Date:** 7/1/87

(Present) Proposed **Sheet** 2 of 2 **Chart by** M. Jensen

Dept. Fabricating

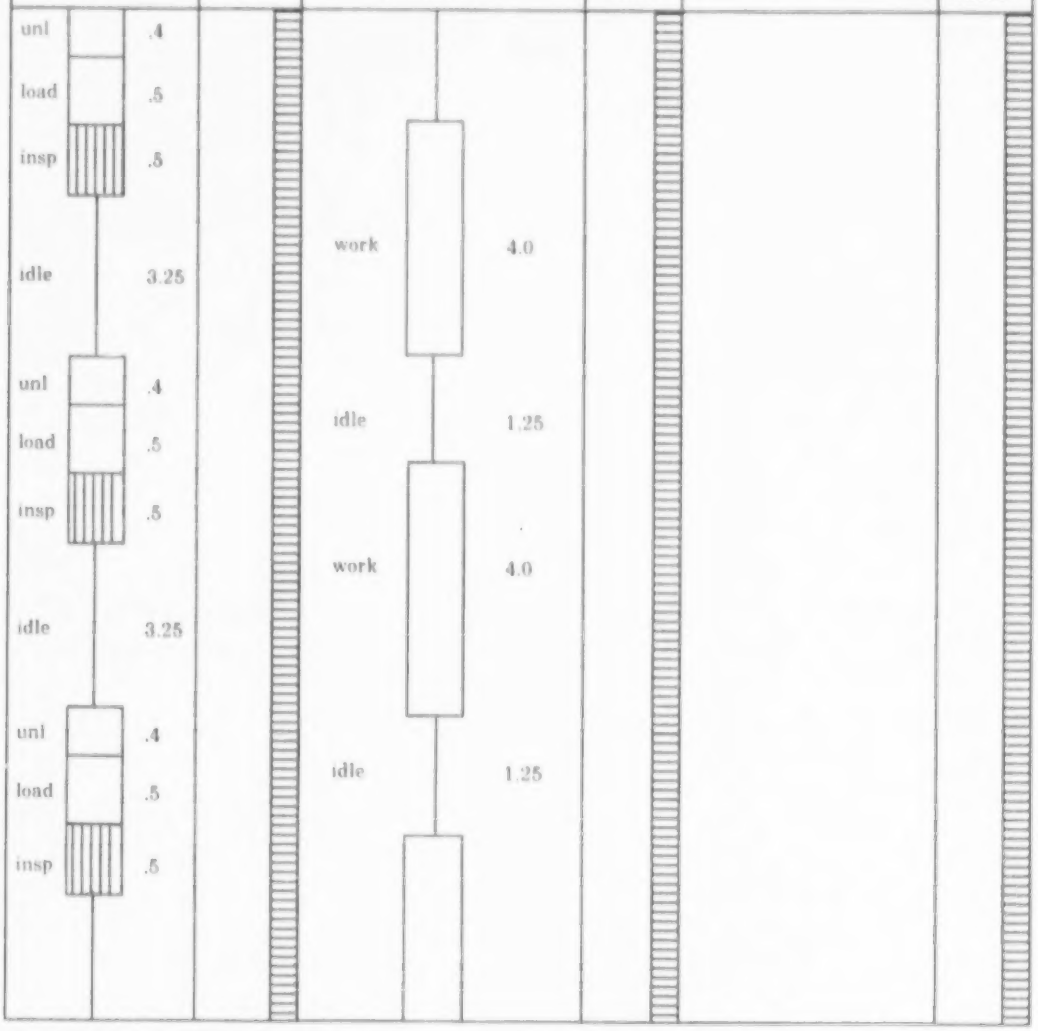


Chart developed by Dr. D. Stallsmith, University of Wisconsin Stout, Menomonie, WI 54751.

Process Problem (Machine 1)
Person/Machine Process Chart

Operation	Mill Keyway Slot
Equipment	Bridgeport Mill #1
Operator	Jane Smith
Analyst	D.S.
Study No.	1

	Person		Machine	
	Time	%	Time	%
Work	2.0	33	4.0	67
Idle	4.0	67	2.0	33

Subject Automatic Milling **Date:** 7/1/87

Present / **Proposed** **Dept.** Fabricating **Sheet** 1 **of** 1 **Chart by** D Stallsmith

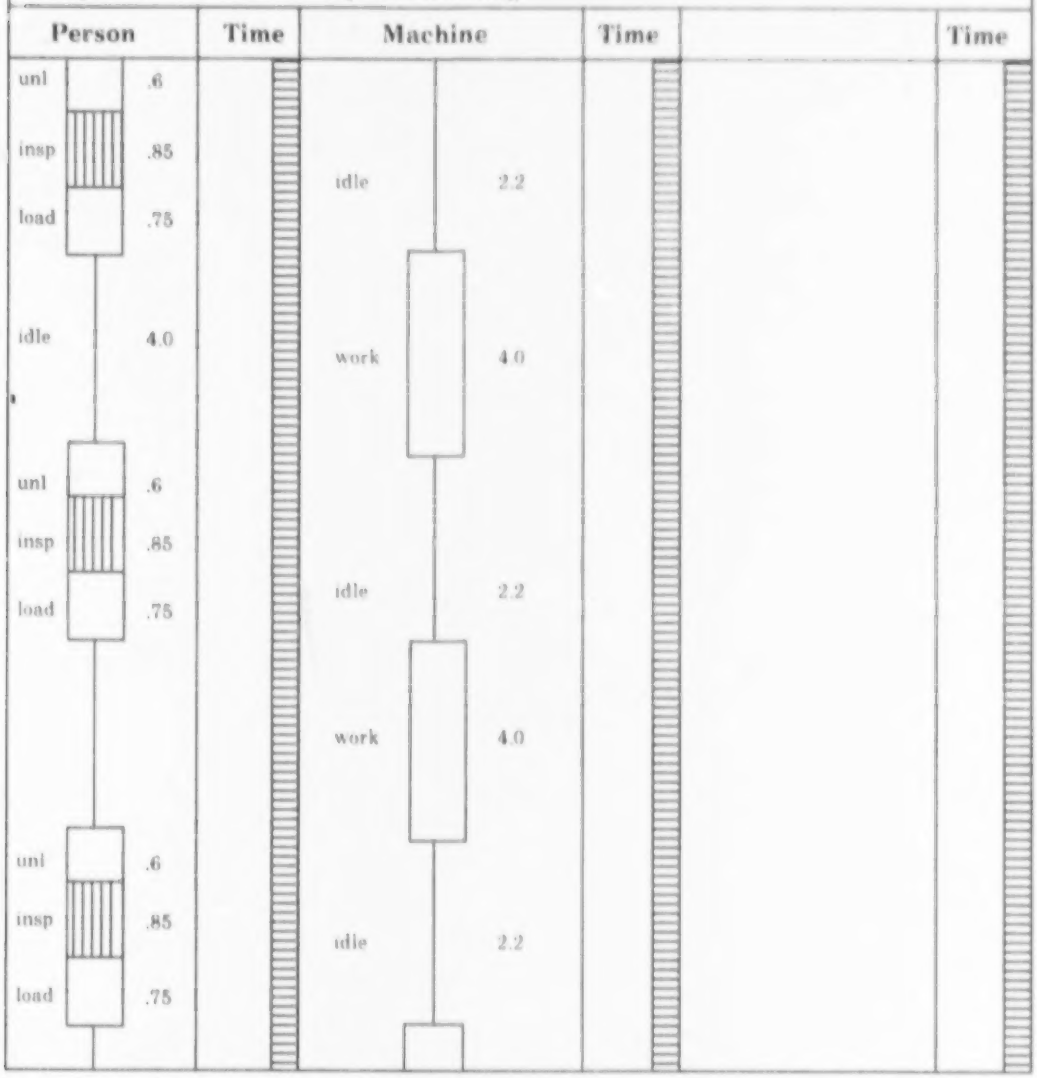


Chart developed by Dr. D. Stallsmith, University of Wisconsin-Stout, Menomonie, WI 54751.

Process Problem (Machine 2)
Person/Machine Process Chart

Operation Mill Keyway Slot
Equipment Bridgeport Mill #2
Operator Jane Smith
Analyst D.S.
Study No. 1

	Person		Machine	
	Time	%	Time	%
Work	2.0	33	4.0	67
Idle	4.0	67	2.0	33

Subject Automatic Milling **Date:** 7/1/87

Present / **Proposed** **Dept.** Fabricating **Sheet** 1 **of** 1 **Chart by** D. Stallsmith

Person	Time	Machine	Time		Time
unl .5		idle 2.0			
insp .75					
load .75					
idle 4.0		work 4.0			
unl .5					
insp .75		idle 2.0			
load .75					
		work 4.0			
unl .5					
insp .75		idle 2.0			
load .75					

Chart developed by Dr. D. Stallsmith, University of Wisconsin-Stout, Menomonie, WI 54751.

Capacity Requirements Planning

Name _____

Class/Period _____

Person/Machine Process Problem

Begin by reviewing the process problem "Person/Machine Process Charts" for Machine 1 and Machine 2. Read and analyze each chart. Complete the blanks below.

Machine 2 Data

Load time _____
Inspect time _____
Unload time _____
Process time _____

Operator cost per hour $ 8.50
Machine cost per hour $ 14.75

Machine 1 Data

Load time _____
Inspect time _____
Unload time _____
Process time _____

Machine cost per hour $ 13.35

Enter your data into the computer, utilizing the program software "Person/Machine Chart Analysis," and make a printout. From the printout, answer the following questions, which will help you evaluate, compare, and analyze costs and capacity of the milling machine production operation.

Questions

1. Which machine requires a longer external setup time? Why?

2. Explain why the process times for each machine are the same.

3. How long does each machine wait for the operator? Why should the time be so short?

4. At what percentage is the person utilized?

5. The idle time for Machine 2 is 2.0. The idle time for Machine 1 is 2.2. What is the actual idle time that the person has to wait for the two machines?

6. What are the number of pieces that can be produced in one hour?

7. Based upon the cost per piece, what is your recommendation for production?

8. Explain why it is cheaper per piece to run two machines instead of one.

Capacity Requirements Report

Write a capacity requirements report for your superiors. Please include in your report

the production rate for one person operating two machines;
the part cost for one person operating two machines;
the utilization rates of person and machines;
total cost to produce 20,600 units;
units produced in an eight-hour day; and
time required to make the 20,600 requested.

(3A) Management Functions

Manufacturing

Material Requirements Planning (mrp), an activity supporting the Managerial Processes concept, is designed for approximately 1 class period.

Resources Needed

Equipment

Apple IIe computer system

Material

Material Requirements Planning software, available from
Wisconsin Technology Education Association
University of Wisconsin-Stout
Menomonie, WI 54751

Note: This activity is one part of a larger system called Manufacturing Resource Planning (MRP). Other software components of the MRP system are available from the same source.

Objectives

The student will

read, analyze, and calculate a "time bucket;"
compare mrp calculating to traditional forecasting methods; and
run the *Material Requirements Planning* software.

Evaluation Focus

☐ Knowledge	☒ Problem Solving	☐ Attitude
☐ Awareness	☐ Machine/Tool Usage	

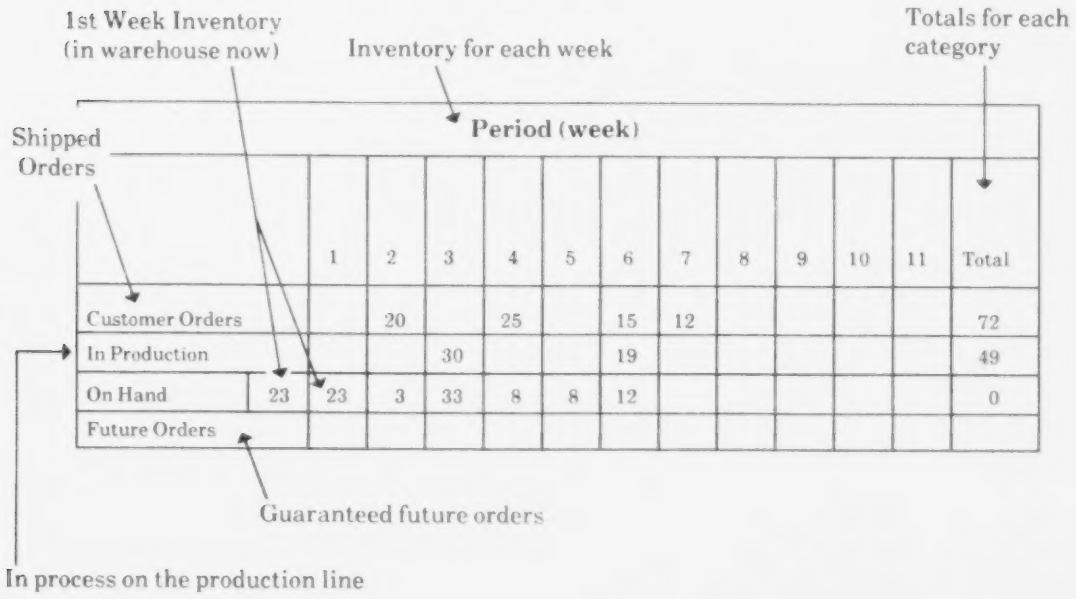
Material Requirements Planning

Procedure

Material Requirements Planning (mrp) is the heart of Manufacturing Resource Planning (MRP). Material Requirements Planning takes information from the master production schedule, production planning, resource Requirements Planning plan, inventory control, capacity requirements plan, purchasing, bill of materials, and shop floor control to determine the demand for items (materials, supplies, etc.) by calculation and then time-phases all inventory. This technique keeps warehousing materials to a minimum to keep costs down, yet produces enough products to send to the customer. Using data from all aspects of the production management system provides the ability to *calculate* need rather than *forecast* need and gives a more exact count of materials and products within a tolerable time phase.

Some sense of this kind of planning can be gained in this activity. You will be learning to analyze "time buckets" and will be working with a software package that facilitates inventory calculations.

1. The objective will be to make a comparison between "forecasting production demand" and "calculating time buckets" with *Material Requirements Planning* software. The first thing you will need to do is study the time bucket below and become familiar with its elements. Be certain you understand how the total "on-hand" numbers are derived.



2. Once you have thoroughly studied the time bucket and understand its elements, you can investigate a realistic time bucket situation and calculate the product demand for customer orders. Time Bucket 1 calculates the demand for gumball machines for a period of nine weeks.

Time Bucket 1

Forecast Period 9

Period (week)													
		1	2	3	4	5	6	7	8	9	10	11	Total
Customer Orders			200		250		150	120	150	40			910
In Production				300			190	200					690
On Hand	230	230	30	330	80	80	120	200	50	10			10
Future Orders										12			12

3. At Week 9, the customer ordered 40 more machines. Using the computer program *Material Requirements Planning*, determine how many machines "forecasting" would have selected for Week 9. You will need the following information: number of time periods = 8; smoothing constant = .5; and values for period = see customer order for each.

4. **Answer Questions 1 through 4 on the Student Response Sheet.**

5. Time Bucket 2 provides another problem to compare. This problem includes the concept of "lead time offset." Lead time offset is the changing of future orders into a customer order; it takes two periods to change. Use the computer program to forecast the Week 9 order.

Time Bucket 2

Forecast Period 9

Period (week)													
Lead Time Offset = Two periods		1	2	3	4	5	6	7	8	9	10	11	Total
Customer Orders			300	100	50	300	10	50	0	200			1100
In Production				100	200	110	0	100	140				700
On Hand	540	540	240	240	390	200	10	60	200	0			0
Future Orders					100			200					300

6. **Answer Questions 5 through 7 on the Student Response Sheet.**

Material Requirements Planning

Name _____

Class/Period _____

1. How many gumball machines are forecast for Week 9?

2. At $5.99 each, what is the cost to carry the inventory?

3. A future order for 12 machines is listed for Week 9. Subtracting that from inventory, how much is setting in inventory?

4. Using the mrp Week 9 calculation of 10 machines on hand in inventory (after distributing the 40 machines ordered), what do you need to do to meet the future order?

5. How many gumball machines are forecast for Week 9?

6. How many do you need to produce to meet the order?

7. If it takes one period to produce 100 products, how long will it take to meet the customer order?

(3A) Management Functions

Manufacturing

Production Planning, an activity supporting the Managerial Processes concept, is designed for approximately 1 class period.

Resources Needed

Equipment

Apple IIE computer system

Materials

Flow Process software, available from
Wisconsin Technology Education Association
University of Wisconsin-Stout
Menomonie, WI 54751

Note: This activity is one part of a larger system called Manufacturing Resource Planning (MRP). Other software components of the MRP system are available from the same source.

Suggested References

Fales, James et al. *Manufacturing—A Basic Text*. Encino, CA: Glencoe Publishing Co., 1986.

Wright, Thomas. *Manufacturing*. South Holland, IL: Goodheart-Wilcox Co., 1976.

Objectives

The student will

learn about routing, scheduling, dispatching, and expediting;
develop a flow process chart;
read an operation process chart; and
run the *Flow Process* software program.

Evaluation Focus

- [x] Knowledge
- [ ] Awareness
- [x] Problem Solving
- [ ] Machine/Tool Usage
- [ ] Attitude

Production Planning

Procedure

Production planning is the function of an enterprise that must be operating before the manufacture of a product. According to Jensen and Wright in their book *Manufacturing*, production planning is concerned with

> the number of products to be built;
> when and where to build them; and
> maintaining production schedules.

The work of production planning consists of three main areas that take a production order and carry it to the completion point. The three areas of production planning are

> *routing*, planning of the path or flow the product will take in the production line;
> *scheduling*, time-planning method establishing when the product will be manufactured; and
> *dispatching*, providing the orders to start production.

One area of production planning is in charge of controlling the total sequence. This area is *expediting*.

Functions of Production Planning and Control

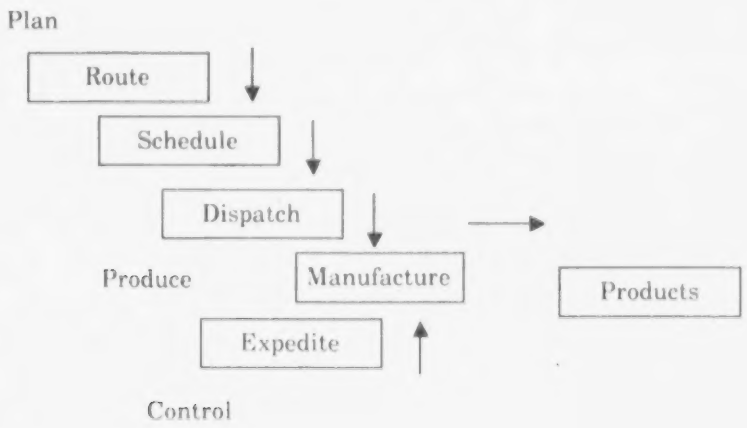


Chart taken from Thomas Wright. *Manufacturing*. South Holland, IL: Goodheart-Wilcox, 1976.

Flow Process Charting

The planning tool for routing a path for manufacturing a product is the "Flow Process Chart." A sample for producing a candleholder is given. However, before the Flow Process Chart is developed, a rough sketch of manufacturing steps is made called the "Operation Process Chart." A sample for producing a wooden whistle is given of this kind of chart. It is primarily a routing sheet comprised of production operations and inspections. The Flow Process Chart, on the other hand, is a more detailed operations chart in that it includes storage, transportation, and delay points that will occur in the manufacture of the product. Both the Flow Process Chart and the Operation Process Chart utilize symbols to graphically depict the routing of the product.

Operation—the characteristics of an object are intentionally changed.

Transportation—an object is moved from one location to another.

Inspection—an object is examined.

Storage—object is kept and protected against unauthorized removal.

Delay—object is waiting to enter next activity.

Combined Activity—two activities are performed concurrently at the same work station; i.e., an operation and inspection combined or an operation performed while in transit.

Flow Process Activity

You will be able to plan your own production sequence by using the routings of an Operation Process Chart to complete a Flow Process Chart. This may appear easy, but you will be making decisions about transportation, storage, delays, and combined activities. You will be using the *Flow Process* computer program to create your computerized chart. The software program contains all the information you need to run it. Follow these steps to get started.

▶ Caution

The computer should be operated only with your instructor's permission and/or presence.

1. Place disk in drive and turn on the computer.
2. From the menu, select "Flow Process."
3. Once you have the flow process main menu, select "Create."
4. You now must provide a product name for filing purposes.
5. Review the Operation Process Chart and sketch in where you think the transportation, storage, delays, and combined activities may fit in the sequence. Review the sample Flow Process Chart.

6. Begin entering the task number, description, machine required, and tooling required for each process activity. Type "end" when you have finished entering tasks.

7. Upon completion of the computerized chart, return to the program main menu for options to "Edit" or "Look." By selecting "Look," you will reach the print option.

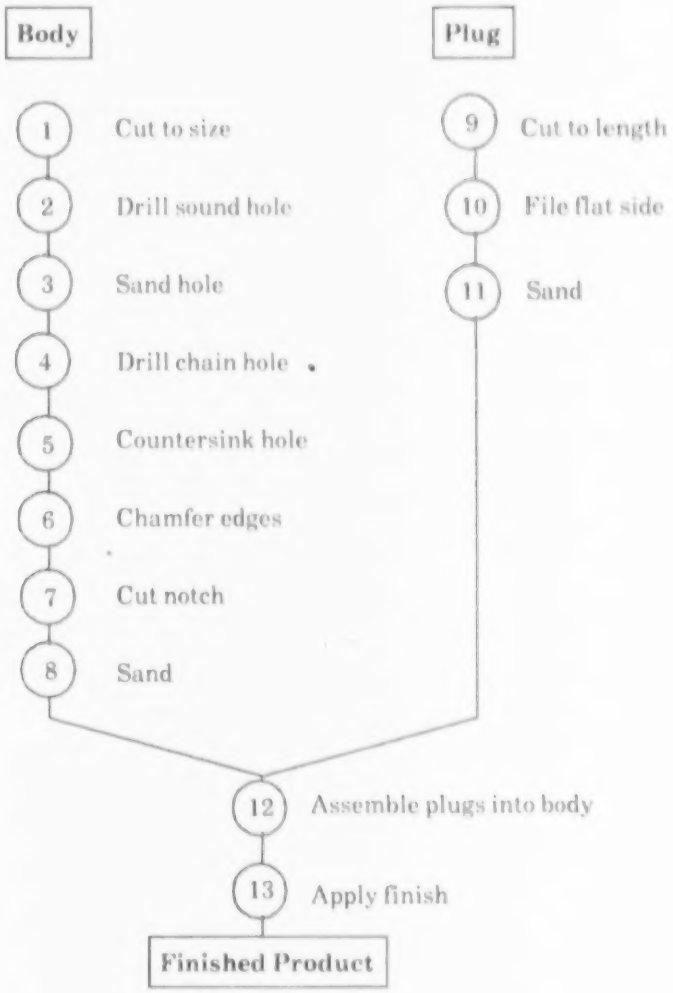
8. Print a copy to hand in to your instructor.

Candleholder Flow Process Chart

S–Storage O–Operation D–Delays T–Transportation I–Inspection

Task No.	Description of Task	Machine Required	Tooling Required
S–1	Store material	None	None
T–1	Transport to surfacer	Surfacer	Ruler
O–1	Surface to 3/4"	Surfacer	Ruler
T–2	To radial arm saw	Conveyor	None
O-2	Cut to length 31"	Radial arm saw	Stop block
T–3	To jointer	Conveyor	None
O–3	Joint one edge	Jointer	None
T–4	To table saw	Conveyor	None
O–4 Stick	Rip to 2" width	Table saw	Ruler/push
T–5	To table saw No. 2	Conveyor	None
O–5	Cut to 6" length	Table saw	Jig No. 1
1–1 UGE	Inspect size	None	Go, no-go gauge
T–6	To band saw	Box	None
O–6	Cut curves to shape	Band saw	Jig No. 2
T–7	To drill press	Box	None
O–7 Jig #3	Drill 3/8" hole	Drill press	Auto/feed
T–8	To spindle sander	Box	None
O–8	Sand curves only	Spindle sander	None
T–9	To belt sander	Box	None
O–9	Sand ends only	Belt sander	Miter gauge
T–10	To bench	Auto conveyor	None
O–10	Sand with orbital sander	Orbital sander	None
1–2 For holes	Inspect appearance	None	Plug gauge
O –11	Check sanding	None	Sandpaper

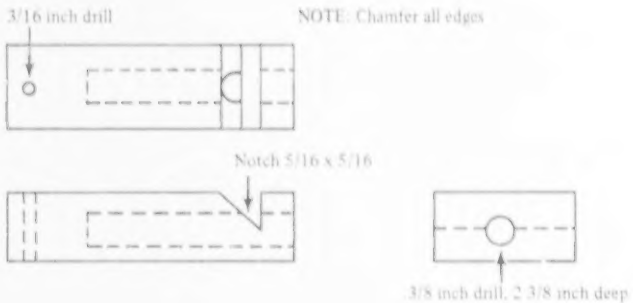
Wooden Whistle Operation Chart



Wooden Whistle Drawing and Parts List

Parts List:

1 body (5/8" x 1" x 3" birch)
1 plug (3/8" dia. x 3/4" birch dowel)



Adapted from James Fales, et al. *Manufacturing—A Basic Text.* Encino, CA: Glencoe Publishing Co., 1986.

(3A) Management Functions

Manufacturing

Production Scheduling, an activity supporting the Managerial Processes concept, is designed for approximately 1 class period.

Resources Needed

Equipment

Apple IIE computer system

Materials

Gantt Chart computer software, available from
Wisconsin Technology Education Association
University of Wisconsin-Stout
Menomonie, WI 54751

Note: This activity is one part of a larger system called Manufacturing Resource Planning (MRP). Other software components of the MRP system are available from the same source.

Suggested References

Fales, James et al. *Manufacturing—A Basic Text.* Encino, CA: Glencoe Publishing Co., 1986.

Wright, Thomas. *Manufacturing.* South Holland, IL: Goodheart-Wilcox, 1976.

Objectives

The student will

understand "lead" time;
use "Bill of Materials" levels to aid scheduling;
schedule to meet a delivery date; and
run the *Gantt Chart* software.

Evaluation Focus

☐ Knowledge	☒ Problem Solving	☐ Attitude
☒ Awareness	☐ Machine/Tool Usage	

Production Scheduling

Procedure

In order to estimate the amount of material required for a particular production run, the materials manager must use the "Master Production Schedule." Using the schedule properly shows the materials manager the right "lead time" needed to have the correct amount of materials delivered in time for production. Avoiding shortages and eliminating excess inventory are the keys to running a complete Manufacturing Resource Planning (MRP) system and the Master Production Schedule is the tool used to provide a timeline for ordering materials. One of the best visual representations of a timeline is a Gantt Chart.

The Gantt Chart

Developed by Henry L. Gantt, an industrialist, a Gantt Chart is very versatile and can be adapted to provide a timetable for the scheduling of materials and amounts, ordering and receiving materials, starting and completing parts, completion of the subassemblies, and final assembly of the product. The chart is universal enough to accomodate any company need in scheduling. For instance, a chart may be used to schedule the complete setup of a company over a number of weeks (Figure 1), or it may be used to schedule production of one part for one week (Figure 2).

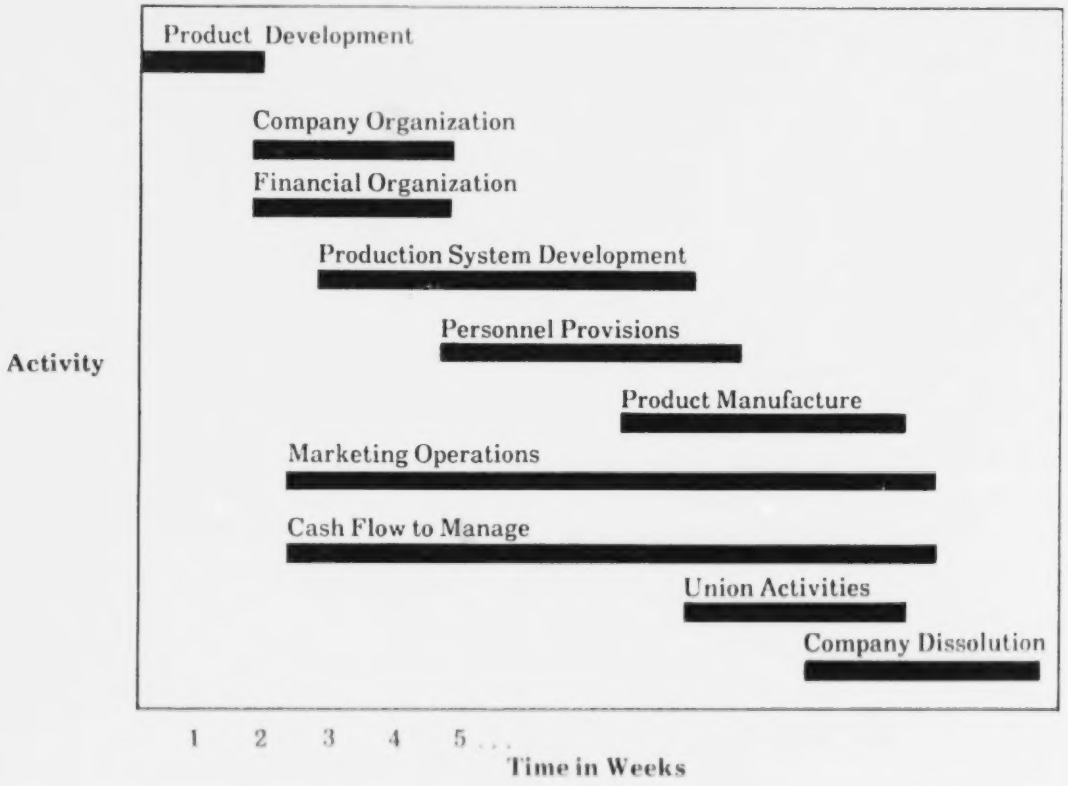
Gathering Information—the Bill of Materials

To create a Gantt Chart, one must have the necessary production information to schedule and develop graphically. One of the best sources of information is the "Bill of Materials" (BOM), especially if it is an Indented Bill of Materials. The indented bill shows the production level at which each product part is used so that the material manager will know which part needs to be ordered/manufactured first, second, third, and so forth. Study the Indented Bill of Materials for the gumball machine. Higher level numbers have first priority; lower level numbers have last priority. The synopsis from the gumball machine BOM would be

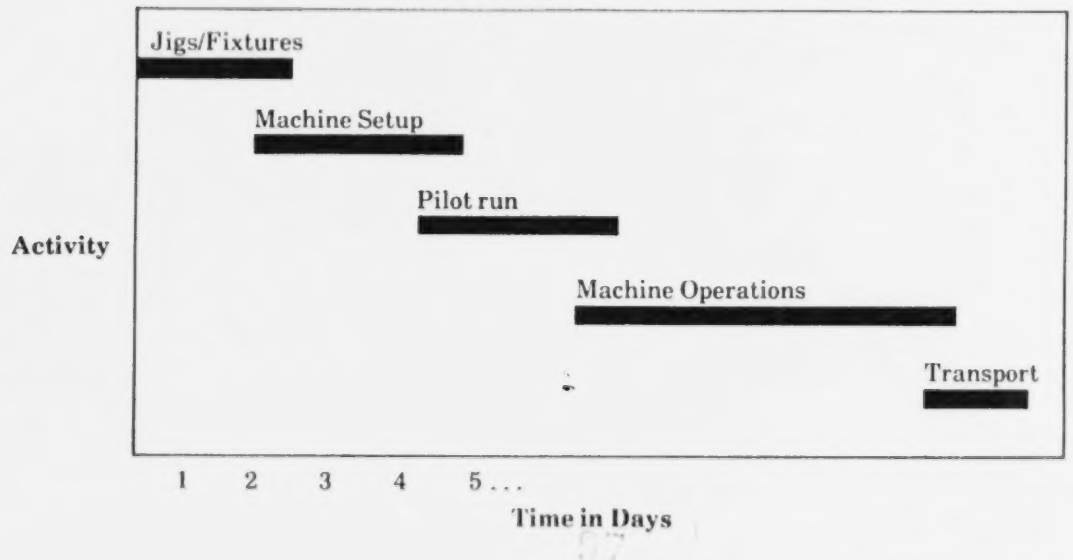
Level 0 = No. 65256 inventory/item number (the finished product);
Level 1 = No. 45234-4536 item numbers (subassemblies); and
Level 2 = No. 25216-25224 item numbers (components of subassemblies).

Company Set-Up Gantt Chart
Activity
Figure 1

Company Set-Up Gantt Chart



Gumball Machine Base Gantt Chart



Gumball Machine—Indented Bill of Materials

Item No.	Description	Quantity
65256	Gumball machine assembly	1
45234	Machine base subassembly	1
25216	Screws, wood, #8 x 11/4" FH	2
25217	Base, wood—oak 1"	1
45235	Machine body subassembly	1
25218	Body, wood—oak 2"	1
25219	Spindle, 1" birch dowel	1
25220	Pin, 1/4" birch dowel	1
45236	Jar subassembly	1
25221	Mason jar, pint size	1
25222	Lid, open top Mason type	1
25223	Screws, #4 x 1/2" RH	3
25224	Gumballs, 5/16" dia.	50

Gantt Chart Problem

A major customer has called your company, Gumball Enterprises, and ordered 5,000 gumball machines. You have told the customer that there is no problem in meeting the order by Week 14. Your main problem is how to schedule it. You know which parts you need to either make or order and the time it takes to accomplish various production steps.

Activity/Item	Time to Accomplish
Order parts, Nos. 25216, 25221, 25222, 25223, 25224	1 week
Mfg parts, Nos. 25217, 25218, 25219, 25220	4 weeks
Subassembly of parts, Nos. 45234, 45235, 45236	2 weeks
Assembly of part, No. 65256	2 weeks
Packaging of products	1 week

You will use a computer program with the Apple computer to develop a Gantt Chart for scheduling this production order. Use the following steps to run the *Gantt Chart* computer program, using the information provided to develop your own chart.

▶ Caution

The computer should be operated only with your instructor's permission and/or presence.

1. Place disk in drive and turn on the computer.

2. Select and run the *Gantt Chart* program.

3. When prompted, type the name of the project, using "Gumball Machine Production."

4. The computer will ask for the numbers of items you wish to input. An item is the activity/item that needs to be scheduled and dated. There are five on the problem chart.

5. The computer will now ask for the activity/item, the start date (by week number), and finish date (by week number).

6. Enter the activities/items and dates.

7. At the end of entering the information, ask for a printout.

8. Hand in your Gantt Chart printout to your instructor.

(3A) Management Functions

Manufacturing

Production Work Order, an activity supporting the Manufacturing Processes concept, is designed for approximately 1 class period.

Resources Needed

Equipment

Apple IIE computer system

Materials

Production Work Order computer software, available from
Wisconsin Technology Education Association
University of Wisconsin-Stout
Menomonie, WI 54751

Note: This activity is one part of a larger system called Manufacturing Resource Planning (MRP). Other software components of the MRP system are available from the same source.

Objectives

The student will

understand the concept of shop floor control;
use information from a "Flow Process Chart" to complete a "Production Work Order"; and
run the *Production Work Order* computer software.

Evaluation Focus

☒ Knowledge	☒ Problem Solving	☐ Attitude
☒ Awareness	☐ Machine/Tool Usage	

Production Work Order

Procedure

The "Production Work Order" is developed by management to tell the production line what should be produced and the quantities. This technique is part of "Shop Floor Control," and the "Production Work Order" is the document that carries all the information required to run the line. It provides the detailed instructions for a work station in the production system.

Usually, a Production Work Order is derived from a single task/operation of the "Flow Process Chart." Included in this activity is a sample of a Production Work Order, so you can see how one is completed, and a sample of a Flow Process Chart, so you may select a task/operation to get started with this activity. Using the Apple computer system and the Production Work Order software, you will produce your own Production Work Order for this job.

▶ Caution

The computer should be operated only with your instructor's permission and/or presence.

1. Place the disk in the drive and turn on the computer.
2. Run the program *Production Work Order*.
3. Once you reach the main menu, select "E".
4. You now have the Production Work Order form displayed.
5. Select "H" which will provide you with necessary instructions and edit commands to complete the work order.
6. After reading the "Help" commands, you should have the form displayed again.
7. Select "P", and input the name of your product. (**Note:** The product name will now be found on all work order pages. This name also becomes the file name.)
8. Begin by selecting "C" to change the line of the work order form. Try the following example:

    A. Punch "C".

    B. Change What? [computer responds].

    C. Type "MB" ⟨return⟩.

    D. Machine/Bench: [computer responds].

E. Push "H".

F. ?_____[computer responds].

G. Type "Table Saw" (return).

"Table Saw" should now appear on the Production Work Order form. If it does, continue with the activity. If not, try again.

9. Complete the work order.

10. Ask your instructor to check your work.

11. Once you have completed all work order forms (do not exceed 50 forms), you may select "E" to return to the main menu.

12. Select "P" to see the print menu.

13. Push "A" to turn on the printer port.

14. **Note:** Be sure to have the printer turned on.

15. Push "B" and follow the instructions.

16. Upon receiving the printed copies of the Production Work Order forms, write brief statements for the "Detailed Operational Procedures" and the "Detailed Quality Control Procedures" on each form.

17. Review all your work order forms and check for mistakes.

18. Hand in the Production Work Order forms.

Production Work Order Form

Part Candle holder				**Page No.** 1			
Machine/Bench Table saw **Part Name** Candle holder base **Drwg. No.** 98-45-678 **Jig/Fixture** **PrWork Station** 0-4				**Operation No.** 0-5 **Part No.** 1-357 **No. of Pcs.** 200 **Tool to be Used** None **NxtWork Station** I-1			
Material Specification #2 Common butternut				**Finished Dimension** 3/4" x 2" x 6"			
Detailed Operational Procedures Using a stop block and miter gauge, crosscut 3/4" x 2' X length pieces of butternut into 6" lengths				**Detailed Quality Control Procedures** Check every tenth piece for 6" length $\pm$ 1/32"			
Operat.	**Date**	**No. Produced**	**No. Rejected**	**Operat.**	**Date**	**No. Produced**	**No. Rejected**
1.				6.			
2.				7.			
3.				8.			
4.				9.			
5.				10.			
Developed by _____ Production Control				**Approved by** _____ Production Manager _____ Quality Control			

Candle Holder Flow Process Chart

S–Storage O–Operation D–Delays T–Transportation I–Inspection

Task No.	Description of Task	Machine Required	Tooling Required
S–1	Store material	None	None
T–1	Transport to surfacer	Surfacer	Ruler
O–1	Surface to 3/4"	Surfacer	Ruler
T–2	To radial arm saw	Conveyor	None
O-2	Cut to length 31"	Radial arm saw	Stop block
T–3	To jointer	Conveyor	None
O–3	Joint one edge	Jointer	None
T–4	To table saw	Conveyor	None
O–4 Stick	Rip to 2" width	Table saw	Ruler/push
T–5	To table saw No. 2	Conveyor	None
O–5	Cut to 6" length	Table saw	Jig No. 1
1–1 UGE	Inspect size	None	Go, no-go gauge
T–6	To band saw	Box	None
O–6	Cut curves to shape	Band saw	Jig No. 2
T–7	To drill press	Box	None
O–7 Jig #3	Drill 3/8" hole	Drill press	Auto/feed
T–8	To spindle sander	Box	None
O–8	Sand curves only	Belt sander	Miter gauge
T–9	To belt sander	Box	None
O–9	Sand ends only	Belt sander	Miter gauge
T–10	To bench	Auto conveyor	None
O–10	Sand with orbital sander	Orbital sander	None
1–2 For holes	Inspect appearance	None	Plug gauge
O –11	Check sanding	None	Sandpaper

(3C) Managed Activities

Manufacturing

Free Form Design, an activity supporting the Managerial Processes concept, is designed for approximately 2 class periods.

Resources Needed

Materials

Inexpensive roll or sheets of paper

Instructor's Option

Many designs might lend themselves to actual production of a three dimensional object (paper clip holder, bowls, nut dish, paperweight). The activity could continue with the students transforming their designs into products, using scrap materials and a variety of standard tools and equipment.

Objectives

The student will

understand the free form design process and how it can generate useful forms;
use a free form design exercise to produce a product shape;
sketch the product; and
reduce or enlarge the product design to appropriate size using the square method.

Evaluation Focus

☒ Knowledge	☒ Problem Solving	☐ Attitude
☒ Awareness	☐ Machine/Tool Usage	

Free Form Design

Procedure

Scribble Method of Design. In this lesson, you will design a project that has a "free form" shape. Free form shapes are different from regular geometric shapes, such as rectangles, circles, or triangles. They are made of gracefully curving lines and seldom have definite names. If they are identified by a name, it usually is very general. For example, the term "kidney shaped" is sometimes used to describe free forms similar to the one shown.

Free form designs are easy to generate since they can be made by anyone who can scribble in a free, unrestrained manner. Figure 1 is an example of free form designs that were produced by scribbling. Notice the free and smooth-flowing lines. Can you see how the shapes might be converted into designs for a three-dimensional object?

Can you distinguish a shape for a free form wooden bowl in this scribble, for example?
Can you find a scroll for an ornamental sign bracket?
Can you discover a basic shape for a table top that can be inlaid with mosaic tile?
Can you see a shape that could be arranged to form a metal sculpture?
Can you visualize a shape that might be suitable for a clock face?
Can you distinguish additional useful shapes?

(**Note:** Small modifications of the lines or shapes may be necessary in order to form a functional and appealing shape.)

Look at Figures 2 and 3 to see how basic shapes from Figure 1 can be transformed into designs for free form objects.

Figure 1

Free Form Design

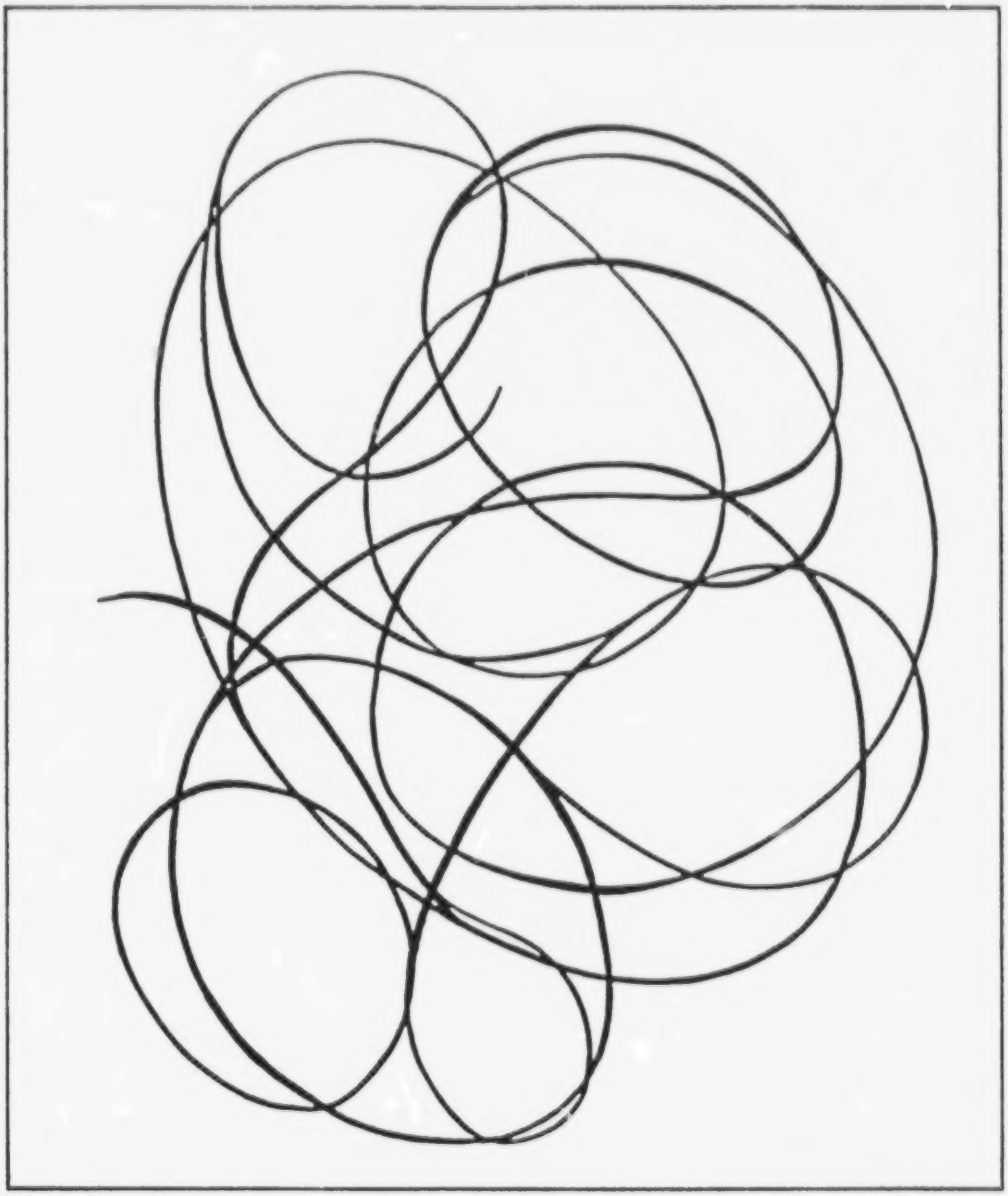


Figure 2

Modified Free Form Design

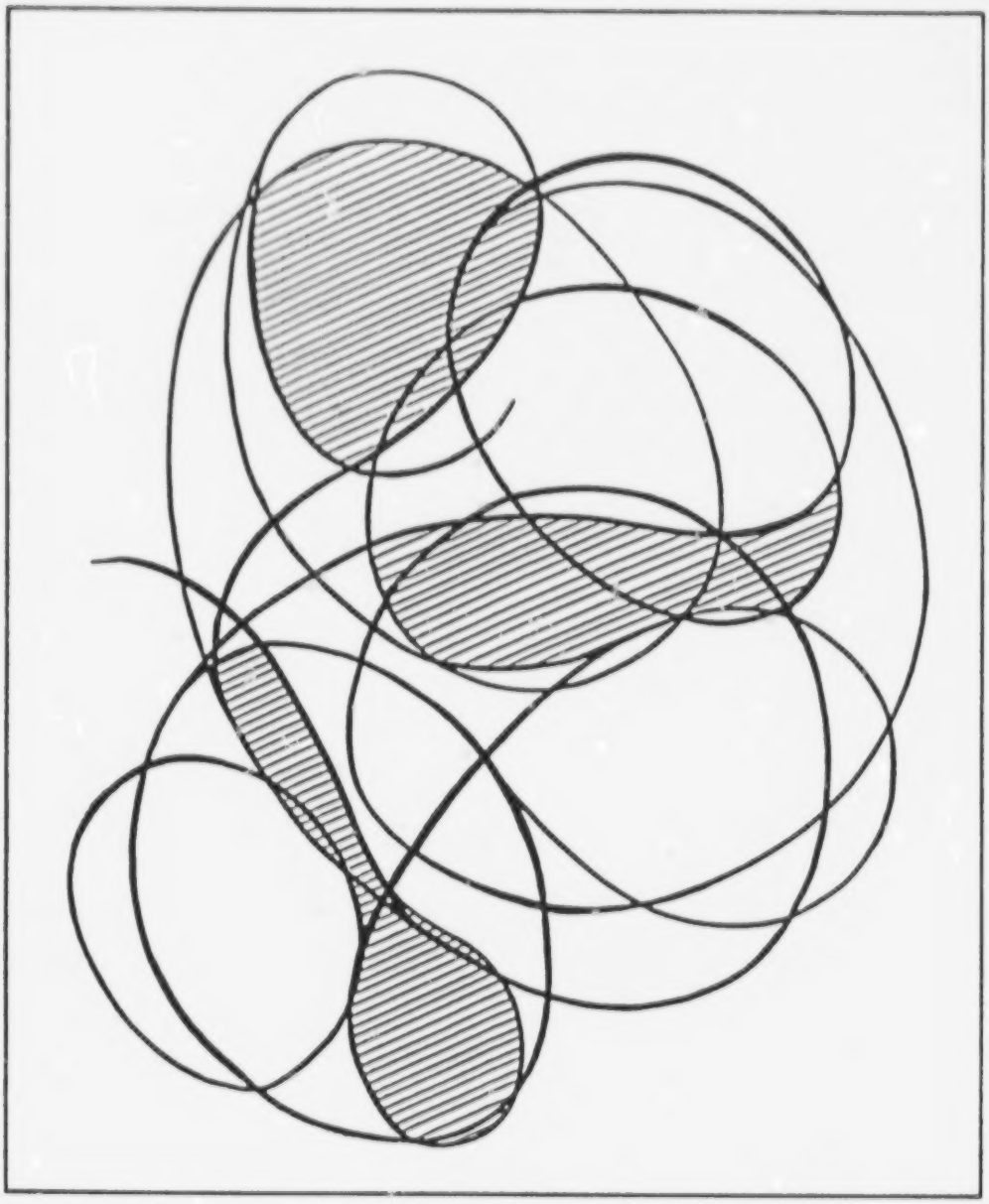
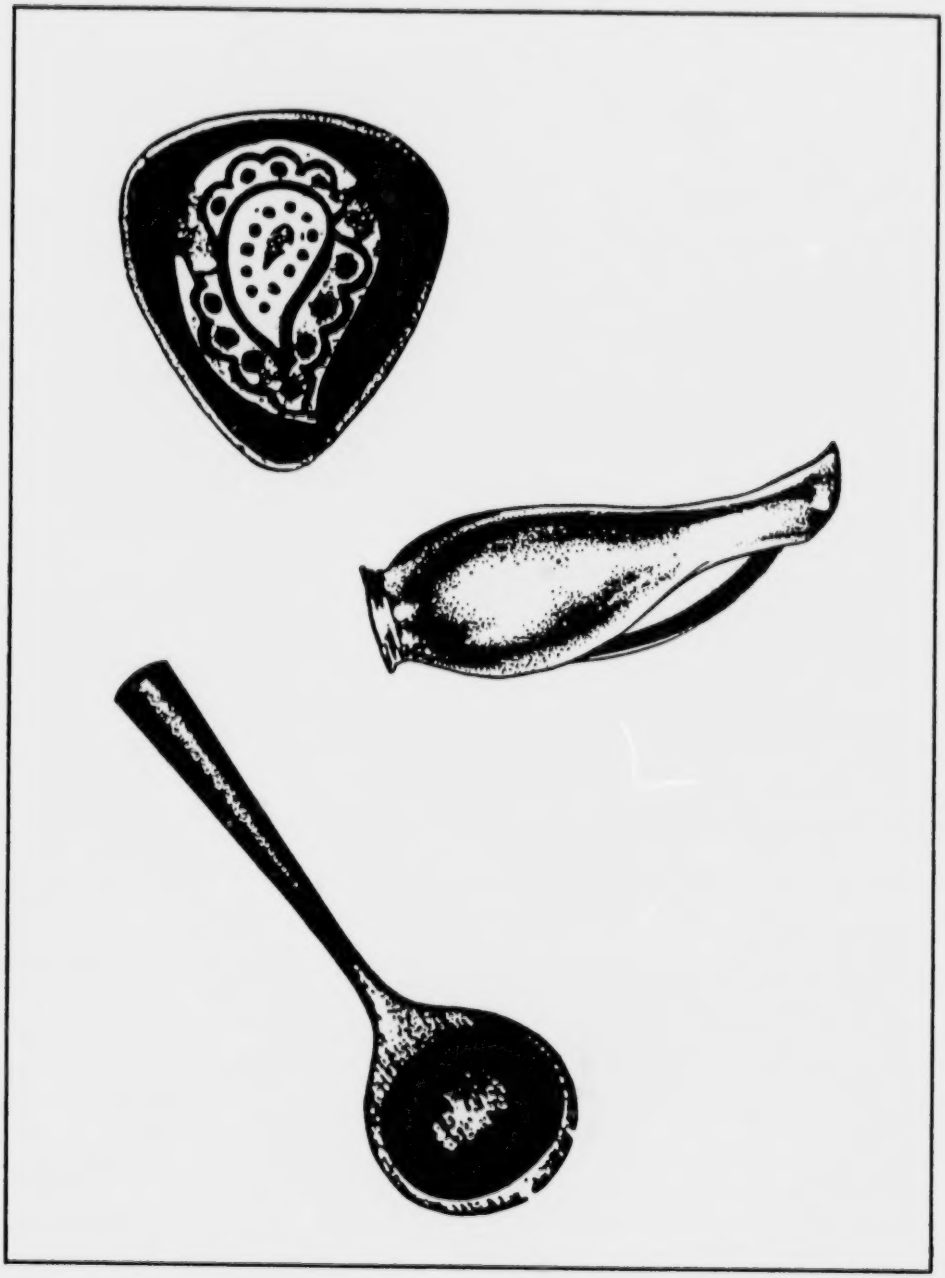


Figure 3

Free Form Design Pictures



Free form objects and designs are made by many people in a variety of occupations. An engineer or drafter may need to design a free form shape for a new product. An automobile body shop may need to create a free form shape to highlight a custom paint job.

Free form shapes are often seen on signs, products, packages, and publications (such as books, pamphlets, magazines, and album covers). The people involved with the production of these items may also, in varying degrees, design free form shapes that will be part of the overall product. The following occupations, to name a few, involve designing:

architect	photographer
display worker	engineer
floral designer	drafter
industrial designer	product designer
interior designer	package designer
landscape architect	graphic designer

1. Now it's your turn to make some free form designs. When making scribbles from which free forms are being selected, it is important to hold the pencil rather loosely and let the arm make free, unrestricted circles and loops at random. Practice making several scribbles on a large piece of paper, trying to cover most of each page with gracefully looping lines.

2. Now look at each of your scribbles, select a few shapes that you like, and trace them with a darker or colored pencil so they will be highlighted on the page. Can any of your free forms be used as a shape for a salad serving spoon, salad or fruit bowl, candy dish, coaster for holding a glass or cup, letter opener, or piece of jewelry?

3. Can other projects be made from the shapes you see in your scribbles?

4. Select the form you like best for an item you would like to make, and make a sketch of what the item would look like if you were to take a picture of the completed project.

5. Determine the appropriate size of the project and enlarge or reduce your free form design to the proper size, using the "squares" procedure shown in Figures 4 and 5. By increasing or decreasing the size of your grid squares, you can control the size of your drawing. Just transfer the lines in corresponding squares from one grid to the other to reproduce your drawing in the proper size. (**Note:** If your design is already the proper size, you need not enlarge or reduce it.)

6. Answer the questions on the Student Response Sheet.

Figure 4

Squares Procedure

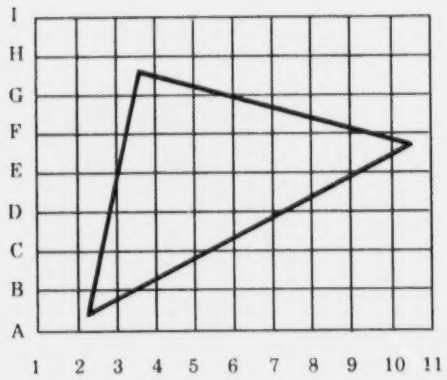
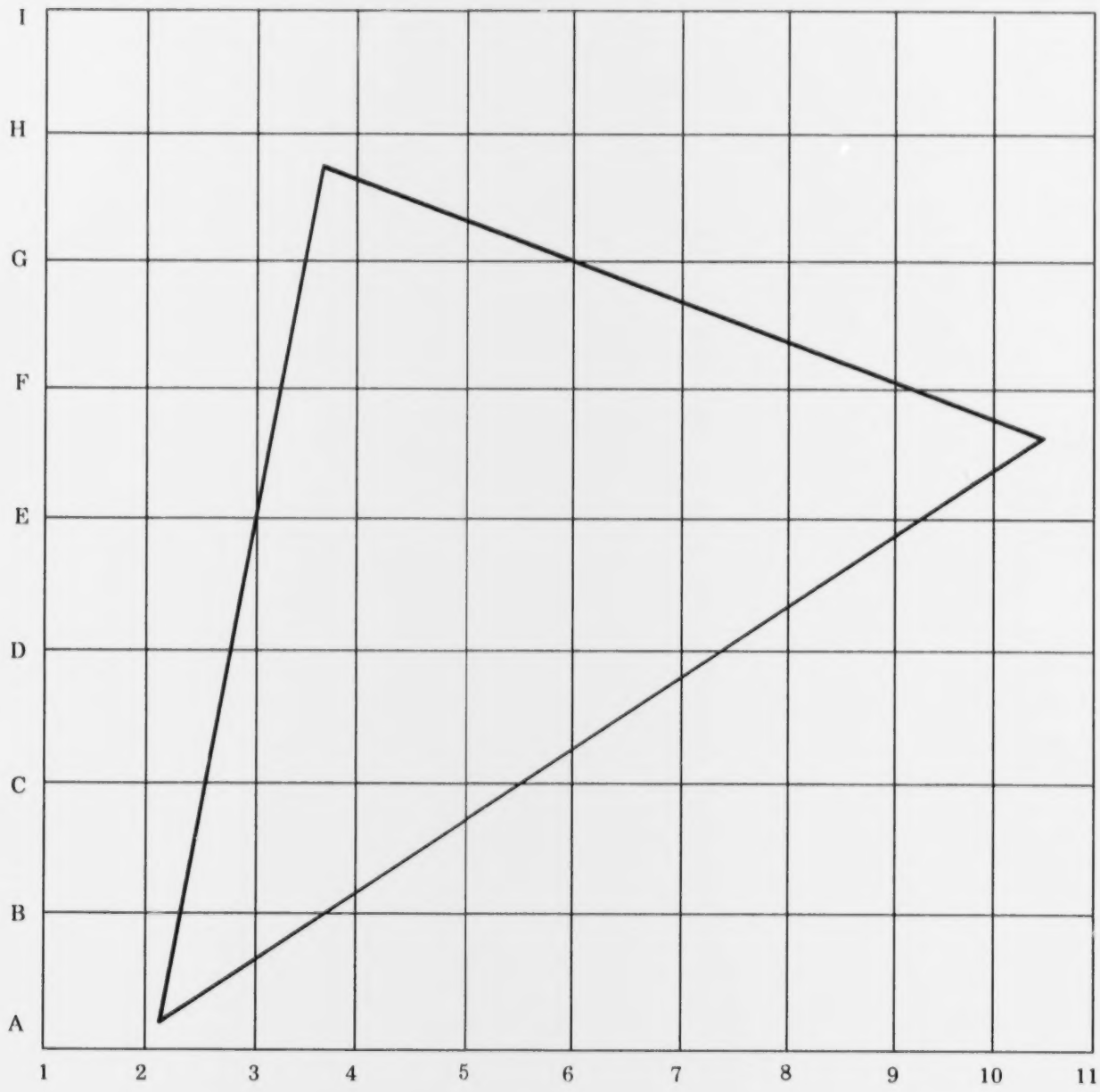


Figure 5

Squares Procedure



Free Form Design

Name _____

Class/Period _____

1. In your own words using complete sentences, describe a "free form" shape.

2. In your own words using complete sentences, tell how a "free form" can be reduced or enlarged in size using the "squares" procedure.

3. Make a drawing of a "free form" shape using the "scribble" method on the reverse side of this sheet.

4. Can you think of any other situations where a person may need to design a free form shape, either for an occupation or for a hobby?

(3C) Managed Activities

Manufacturing

Marketing and Distribution, an activity supporting the Managerial Processes concept, is designed for approximately 2 to 4 class periods.

Resources Needed

None

Objectives

The student will

understand the terms "marketing" and "distribution";
know the types of transportation used by industry in transporting goods and services to consumers; and
plan the procedures for delivering a product from the end of the production line to the consumer.

Evaluation Focus

☒ Knowledge	☒ Problem Solving	☐ Attitude
☒ Awareness	☐ Machine/Tool Usage	

Marketing and Distribution

Introduction

As a society, we consume thousands upon thousands of products and services daily. Few of these products and services are produced locally. Many of them must be secured from hundreds or thousands of miles away. A product manufactured in California may be needed in Maine.

Elements of industry labeled "marketing" and "distribution" are necessary if goods and services are to move from those who make them to those who use them. This activity will explain what marketing and distribution are and explain five of the steps in implementing them into an enterprise.

"Marketing" and "distribution" are terms used by industry to describe the flow of goods and services from producers to consumers. That is, they describe the actions that take place to get goods and services from industry to you.

When you want a loaf of bread, you usually go to the store and buy it. How does marketing and distribution come into the picture? Industry knows that the public wants bread as a basic food product. The baker obtains the materials and the equipment to make the bread. After the bread is baked, marketing and distribution come into play. Marketing includes those actions of an enterprise that create sales and direct the flow of goods and services from the producer to the consumer. Distribution covers moving and storing the products and services, from the time they are produced until a consumer uses them. Can you describe other products or services which depend upon marketing and distribution for delivery to the public?

Steps Involved in Marketing and Distribution

There are five major steps that take place when goods and services are marketed and distributed.

Analyze

Analyzing the market is the first step in marketing and distribution. Research and planning are conducted to determine the factors that may affect the sales of a product or service. An enterprise must determine what to produce, who will buy it, and for what price. This is often referred to as market research.

Advertise

This is the next step in marketing and distribution. When a company advertises, it tries to bring its product or service to the attention of the public in an attempt to create sales to make a profit. There are many possibilities for a company's advertising efforts, but all are directed at finding someone to buy the products or services. Every day you see and hear multiple methods of advertising. They appear on TV, billboards, magazines, and newspapers; and they can be heard in stores and on the radio and TV.

Transportation

This is the process used by industry to physically move materials, products, or services from one place to another place within a company or from the enterprise to stores or directly to customers. Transportation can be further divided according to the medium it uses.

Land transportation includes the largest number of methods of moving goods and services. The most common are trucks, railroads, buses, and cars. Other methods are by wire (electricity), pipe (oil and gas), carts, and animals. Can you think of any others? Conveyors and forklifts are other types of land transportation used by industry. Modern service transportation includes monorails and people-mover conveyors. Can you think of any recreational land transportation methods?

Water transportation has been used for many years. The first settlers to come to America came by boat, a method of water transportation. Barges are another type of water transportation. Around the world, barges are used to transport coal and other materials and products. Boats are also used to transport goods and services. One of the first means of water transportation was by raft, a method of transportation still used in many sections of the world.

Air transportation is the third major type of transportation. It is a relatively new method of transportation compared to land and water transportation. Some examples of air transportation are balloons, airplanes, jets, and rockets, our fastest method of transporting. Space shots use air transportation. Can you think of some other methods of air transportation used by industry?

Storage

This is the next step in marketing and distribution. It is space that has been made available to keep or store products from the time they are produced until the consumer uses them. Storage is also involved in other stages of producing goods and services. It does not always happen after the production of the final product.

Sales

This is the final major step in marketing and distribution. It involves the actual buying of a product by the consumer. There are many ways of selling products and services. You can buy a product from a machine, from a store, or from individuals.

Now that you know the five major steps in marketing and distribution, you should be able to describe how to get a product or service from an enterprise to a consumer. Remember these steps: analyze, advertise, transport, store, and sales. Keeping these in mind, answer the questions on the Student Response Sheet.

Marketing and Distribution

Name _____

Class/Period _____

1. In your own words, define marketing and distribution.

2. List the five major steps involved in marketing and distribution and explain each.

3. Explain and list examples of the following types of transportation:

   land transportation

   water transportation

   air transportation

4. Describe the procedures used in marketing and distribution to get a bicycle from the production line to you.

Analyze

What is a product that your class has produced or plans to produce or that you want to produce yourself? What are some factors you should consider before you go ahead? Explain why this would be a successful product for an enterprise to produce.

Advertise

Given a product that your class has produced or plans to produce or that you want to produce yourself, plan a detailed advertising campaign to make the public want to purchase the product. Study the various types of commercial advertising before you start. You may produce a newspaper ad, poster, flyers, a tape for the radio, or a skit for TV.

Transportation

Given a product that your class has produced or plans to produce or that you want to produce yourself, lay out a detailed sketch of how it would be transported throughout your shop in production and how it would be delivered to the customer.

Storage

Given a product that your class has produced or plans to produce or that you want to produce yourself, develop a detailed written plan for how it would be stored until it is sold to a customer. You may wish to include a sketch or floor plan in this presentation.

Sales

Given a product that your class has produced or plans to produce or that you want to produce yourself, develop a detailed plan for the sale of this product.

(3C) Managed Activities

Manufacturing

Packaging the Product, an activity supporting the Managerial Processes concept, is designed for approximately 1 or 2 class periods.

Resources Needed

Packaging examples (fragile objects, liquids, odd-shaped items)
Sample products to be packaged by students

Objectives

The student will

explore the role of packaging as part of the marketing strategies;
learn five functions of packaging;
consider appropriate packaging methods and materials; and
determine appropriate packaging for a specific product.

Evaluation Focus

☐ Knowledge	☒ Problem Solving	☐ Attitude
☐ Awareness	☐ Machine/Tool Usage	

Packaging the Product

Procedure

Marketing can be the key to success for a product or manufacturer. Even an extremely high quality, low priced product has little chance in the marketplace without efficient, creative marketing. Marketing serves several functions—sales, distribution, inventory, advertising, market surveys, promotions, advertising, and packaging (to name a few).

This activity will explore the role of packaging as part of marketing strategies. It will also explore the methods of packaging and the special considerations used to help determine what type of packaging to use for a particular product.

Begin by reading Frame 1 and following the directions it contains. Many frames will end with a statement containing a numbered blank line. On the Student Response Sheet at the end of this activity, write the word or words that most correctly fill the blanks. **Note:** Do not write on the blank in the frame; use the corresponding lines on the Student Response Sheet for your answers.

Frame 1

Modern packaging must meet consumer demands for freshness, cleanliness, and convenience. It serves at least five distinct functions. A package must

provide a container for the product;
protect the contents;
identify the product;
display and sell the product; and
make it easy to use the product.

Largely because of the growth of self-service stores, the (1) _____ of the product has become very important.

Find the answer in Frame 4.

Frame 2

When picking a packaging material, be sure it will serve as a good container for the product. Liquids would not work very well in a plastic bag, and glass jars would probably break if used for frozen foods.

The first thing to consider when choosing packaging material is that it makes a good (2) _____ for the product.

Find the answer in Frame 5.

Frame 3

The next most important need is to protect the product. A glass container, such as a drinking glass, would hold soda. However, breakage could happen easily when the pop is being shipped or carried home. Therefore, sealed cans or heavy glass bottles are the answer.

The second important packaging requirement is to (3) _____ the product.

Find the answer in Frame 6.

Frame 4

The answer is packaging.

If you got it right, go to Frame 2.

Frame 5

The answer should be container.

Correct? Go to Frame 3.

Frame 6

You should have protect.

If right, go to Frame 7.

Frame 7

Government regulations require that companies properly identify their products. Expensive fines may result from improper labeling and packaging. Company brands and trademarks should be noticeable on a package so advertising done on TV and in magazines can aid sales.

Move on to Frame 8.

Frame 8

Consider the number of products on store shelves. Each competes for the customer's dollar. A bright, colorful package is a powerful selling tool. It convinces the retailer to stock the product and persuades the consumer to buy. This is called "merchandising" a product.

The art of displaying and selling the product can make or break a company. This is called (8) _____ a product.

Find the answer in Frame 9.

Frame 9

The answer is merchandising.

Get it right? Go to Frame 10.

Frame 10

There are many packages that make it easy to use a product. Examples are tissues with a pop-up feature, shoe polish kits that contain a dauber and polishing cloth, and soft drinks in self-opening cans. Recent developments include spray-on bandages and cook-in-bag foods.

Many times a manufacturer will design a package that will make the product (10) _____.

See Frame 13 for the answer.

Frame 11

It's been estimated that half of the total U.S. production of paper probably used in packaging. Grocery bags, shipping sacks, butter wrappers, frozen food wrappers, soap containers, and lightweight paper for delicate items are a few packaging uses of paper. Paper comes in so many varieties that it can be adapted to almost any situation, except for products requiring a completely air-tight package.

Packaging uses (11) _____ in a wide variety of ways.

See answer in Frame 14.

Frame 12

Metals most often are used in the packaging of liquids and processed fruits and vegetables. Cans have been used often, but other applications are pouches and semirigid containers for frozen cakes, TV dinners, and frozen pies. Because aluminum can withstand heat and cold, is easy to store, tasteless, odorless, nontoxic, and hygienic, it is used frequently as a safe packaging material.

One of the metals used most often in packaging is (12) _____.

See Frame 15 for the answer.

Frame 13

The answer is easy to use.

Right? Go to Frame 11.

Frame 14

You should have paper.

If correct, go to Frame 12.

Frame 15

The correct answer is aluminum.

Correct? Go to Frame 16.

Frame 16

A metal container in which the contents are held under pressure and released in small amounts by means of a valve is called an aerosol can. Once used chiefly for insecticides, it now is a popular method of packaging colognes, hair sprays, and many food products. In addition, new uses, such as for self-heating shave cream and for mouthwash, have emerged in recent years.

Recent additions to the packaging field find foods such as cheese being served from (16) _____ cans.

Find the answer in Frame 18.

Frame 17

When a rigid container and visible contents are needed, glass is a possible choice. It has the disadvantage of breaking easily. Although many former glass packages have been replaced by plastic, glass is still used where elegant packaging is desired.

Although glass packages are nice looking, they are being used less. The big problem with glass is that it (17) _____.

The answer is in Frame 19.

Frame 18

The answer is aerosol.

OK? Go to Frame 17.

Frame 19

You should have breaks easily.

Now go to Frame 20.

Frame 20

Plastic is fast becoming the foremost packaging material because it can be used for almost every packaging need. One reason it is being used for more products is the cost of equipment change over. Plastic can be divided into two types—rigid and flexible. Rigid plastic is used in ice cream and margarine containers, for example, and flexible plastic is used in bags, wraps, pouches, and tubes.

Cream would probably be packaged in (20) _____ plastic containers.

See Frame 22 for the answer.

Frame 21

There are various flexible plastic packages being developed. The *blister pack* is plastic that is molded through a thermoforming process into a shape slightly larger than the product.

Skin packs are similar to blister packs, except in this case the plastic film is shaped right over the product itself, rather than being premolded.

The *shrink pack* makes use of a special film that is wrapped over the product and then exposed to hot air. This method can be used for odd-shaped products like hams and cheeses.

List three different flexible plastic packages.

(21) (a.)
(b.)
(c.)

See Frame 23 for the answer.

Frame 22

The answer should be rigid.

OK? Go to Frame 21.

Frame 23

You should have the following in any order:

a. blister pack
b. skin pack
c. shrink pack

Now go to Frame 24.

Frame 24

The federal Food and Drug Administration develops rules for the packaging of foods, drugs, and cosmetics. The Federal Trade Commission has rules that cover most other goods. Packages with false bottoms and other devices used to make a product look bigger are outlawed. Labeling regulations and size of label print are also controlled. Phrases such as "jumbo quart" and "full gallon" are prohibited in order to ensure honest packaging.

Go to Frame 25.

Frame 25

There are many things to consider when designing a package. Some of them are:

What material will be used?
How will it be sealed?
Will it hold up under the handling it will get?
Is the label design effective?
Does it conform to government regulations?
Can the product name be seen easily?
Will it make a good impression on the consumer?
Will it show up well on TV or in other advertising media?

Now that you have worked through all of the frames, it is time to put this information to practical use. You will be given a product by your instructor. Your task will be to analyze the product, determine what kind of packaging would be best for the product, and design a package for it. Fill out the Packaging Checklist as a final part of this activity, answering questions about your product and your package design.

Packaging the Product

Name _____

Class/Period _____

Answer the questions in the frames by recording the word or words that best complete the sentences. Write your answers below.

Frame Number

1.

2.

3.

8.

10.

11.

12.

16.

17.

20.

21. a.

b.

c.

Packaging Checklist

1. Product name _____

2. Package is designed to:

   ☐ protect
   ☐ to provide sales appeal
   ☐ for easy use
   ☐ other _____

3. Physical form of production

   ☐ liquid comment _____
   ☐ solid comment _____
   ☐ gas comment _____
   ☐ other comment _____

4. Characteristics of product

   ☐ fragile
   ☐ sticky
   ☐ lumpy
   ☐ toxic
   ☐ volatile
   ☐ abrasive
   ☐ others

5. Protection required

Yes	No			
☐	☐	temperature	explain	_____
☐	☐	moisture	explain	_____
☐	☐	light	explain	_____
☐	☐	mold	explain	_____
☐	☐	rodents or insects	explain	_____
☐	☐	corrosion	explain	_____
☐	☐	petroleum products	explain	_____
☐	☐	odors	explain	_____
☐	☐	others		_____

6. What features will be required for handling, shipping, or storing?

Sales Appeal

7. Approximate age of potential customer?

8. Approximate income level?

9. Type of selling involved (door to door, sales outlets, etc.)?

10. What sales appeal will best communicate with the customer?

11. Will packages be used as part of a display?

12. Is safety a factor when the customer is handling the package?

    Explain.

13. Can the empty package be reused?

14. What material will the package be made from?

15. Will the package be decorated? How and with what?

16. Will the material accept the decorating?

Final Considerations

17. Has minimum material been used in making the package?

18. Are the weight and size economical for the shipper?

19. Have the design specifications been detailed (drawings, etc.)?

20. Do you have a source of supply for your materials?

Note: Drawings, sketches, and other related information should be attached to this form.

21. Additional comments:

Packaging the Product

Frame Number

1. packaging
2. container
3. protect
8. merchandising
10. easy to use
11. paper
12. aluminum
16. aerosol
17. breaks easily
20. rigid
21. a. blister pack
    b. skin pack
    c. shrink pack

Note: Last three answers (21a, b, and c) may be in any order.

(3C) Managed Activities

Manufacturing

Plant Layout, an activity supporting the Managerial Processes concept, is designed for approximately 1 to 2 class periods.

Resources Needed

Suggested Reference

Wright, Thomas. *Manufacturing*. South Holland, IL: Goodheart-Wilcox Co., 1976.

Objectives

The student will

consider the relationship between plant layout efficiency and company profit;
exercise problem-solving ability; and
design a specific plant layout in response to a production problem.

Evaluation Focus

☐ Knowledge	☒ Problem Solving	☐ Attitude
☐ Awareness	☐ Machine/Tool Usage	

Plant Layout

Procedure

In order for a company to succeed, it must be competitive, and in order for it to be competitive, it must produce its product at the lowest possible cost. One way to reduce the cost of a product is to carefully control the length of time it takes to produce it. One of the most effective ways to decrease production time is to plan an efficient physical path for the product to follow in the plant and strategically place workers along the path.

Design Problem

Assume that you are responsible for establishing a new factory that will construct assembly-line robots. The building has been purchased for the new plant, and now you must design the assembly process and assign the plant personnel. Your goal is to design the most efficient process possible. The efficiency will be measured by the company's profit, and the profit will be determined by the number of completed robots shipped every hour.

Design Considerations

In this plant, you will have to allow for the following work stations:

U1—*unloading* of the motor/power pack assemblies
U2—*unloading* of the robot monitoring systems
U3—*unloading* of the mechanical assemblies
A1—*assembly* of the motor/power pack mechanical assembly
A2—*assembly* of the monitoring system to the power pack/motor mechanical assembly
F—*finishing* of the completed robot by applying paint
T—*testing* of the completed robot assembly
P—*packaging* of the robot assembly for shipping
S—*shipping* of the completed assembly

Exactly 12 employees must be used, and any employee can perform any work task, but the maximum work rate per employee is as follows:

unloading	30 parts/hour
assembly	10 units/hour
finishing	5 units/hour
testing	20 units/hour
packaging	5 units/hour
shipping	10 units/hour

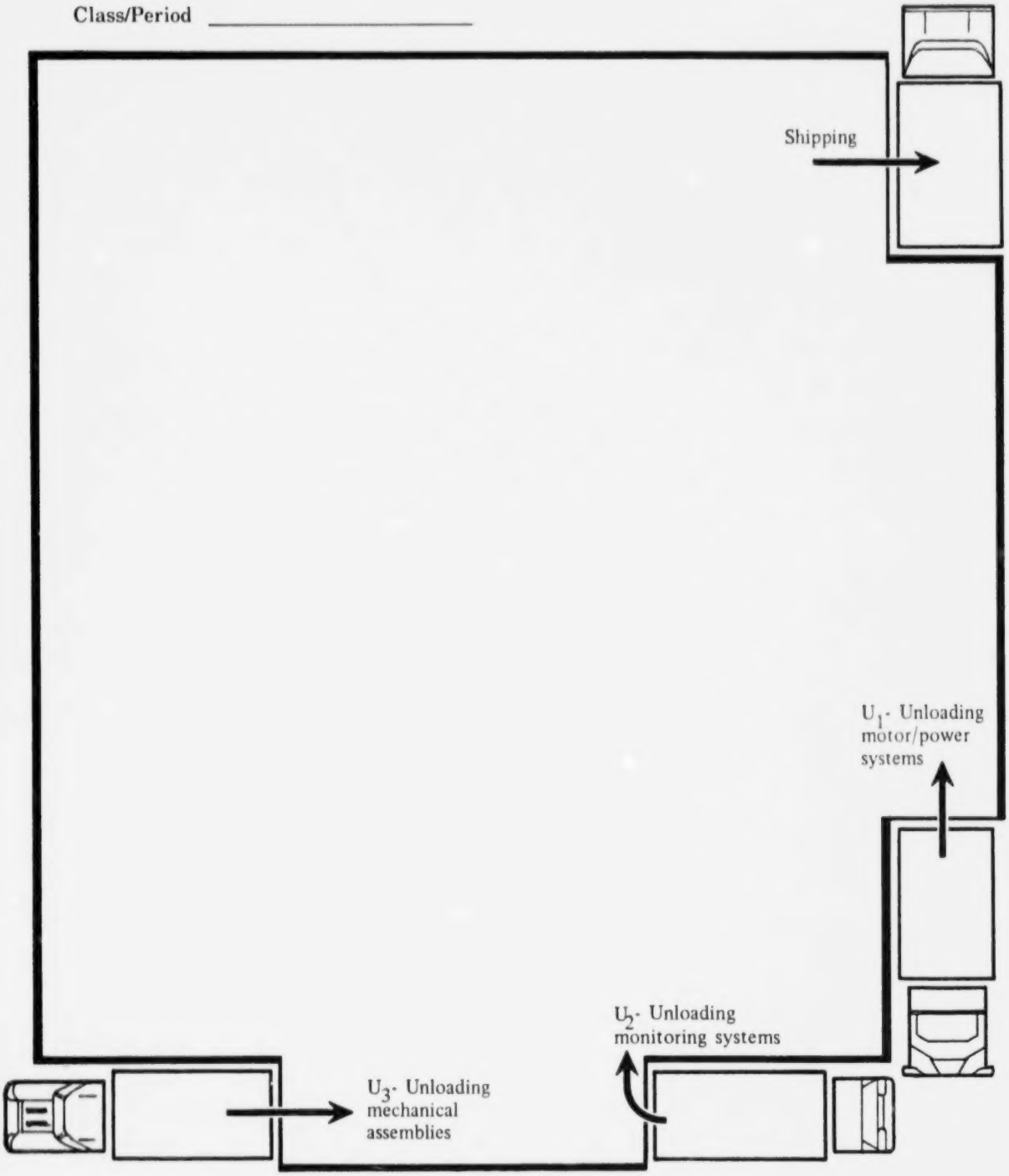
Remember, your goal is to ship as many completed robots per hour as possible. You are limited only in that you must use exactly 12 employees, you must see all work stations, and work can be completed no faster than is listed for each task.

On the floor plan given on the Student Response Sheet, show: (1) the location of each work station, (2) the location of each employee, and (3) the method or means of moving the parts or completed assemblies from one work station to the next.

Plant Layout

Name _____

Class/Period _____



(3C) Managed Activities

Manufacturing

Product Design, an activity supporting the Managerial Processes concept, is designed for approximately 4 class periods.

Resources Needed

None

Objectives

The student will

know three parts of the design process;
solve a design problem;
sketch possible product solutions;
create a working drawing of the final product; and
devise a procedure chart for making the product.

Evaluation Focus

☒ Knowledge	☒ Problem Solving	☐ Attitude
☐ Awareness	☐ Machine/Tool Usage	

Product Design

Procedure

Designing is the complete act of creating a product. When you design a project, you must plan it completely and also make a set of working drawings. The design process is in three parts.

Creativity: This is the expression of your own ideas and feelings in the design.
Technical: This includes the abilities to make working drawings, work from the drawings, and use tools skillfully and actually build the product.
Aesthetic: This is the ability to design something that is appealing to other people.

Once the design is finished, a bill of materials can be drawn up from it, and a production order (or step-by-step procedural plan) can be drafted.

Design Problem

Assume you are an industrial designer. Your company gives you the responsibility to design a product that will provide a place for important keys to be stored when not needed; hold important letters to be mailed the following day; and be fastened to a wall, probably near an entrance. The Design Factor Chart gives additional information that will affect your design.

Design Factor Chart

Factors	Limitations	Variables
Length	9" at one point	—
Width	—	1-1/2" – 4"
Thickness	3/4"	—
Method of hanging keys from device	L hooks	—
Number of letters held	—	2 – 5
Method of holding letters	saw korf	—
Method of hanging device	hole for nail	—
Finish	—	Natural-Deft Stain-Deft

1. Study the Design Factor Chart.
2. Draw four preliminary sketches of possible products that will meet the design criteria.
3. Draw two more detailed preliminary sketches, giving actual dimensions.
4. Construct a working drawing of your final design, top view only, with dimensions.
5. Complete the Bill of Materials.
6. Complete the Production Order.

Product Design

Name ____ _____

Class/Period _____

Preliminary Design Sketches

Sketch 1	Sketch 3
Sketch 2	Sketch 4

Pick two of your sketches and sketch your best ideas in the space below. Include all dimensions needed to lay out the design on your material (see your instructor for material options).

Preliminary Sketch 1

Preliminary Sketch 2

Working Drawing

Bill of Materials

No. of Pieces	Description and Size of Parts	Cost Per Unit	Total Cost
Total Cost			

Production Order (Plan of Procedure)

Step No.	Operation	Machine/Tool Needed
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

(Continue on another sheet if needed.)

(3C) Managed Activities

Manufacturing

Redesign, an activity supporting the Managerial Processes concept, is designed for approximately 2 to 3 class periods.

Resources Needed

Equipment
Work table
Standard drawing tools

Suggested References
Drafting books that show detail drawings

Instructor's Option

The activity could continue with students transforming their designs into a finished product using a variety of standard tools and equipment.

Objectives

The student will
consider how design changes can improve products;
complete a redesign exercise and produce sketches of an improved product; and
make a detailed product drawing.

Evaluation Focus

☐ Knowledge ☒ Problem Solving ☒ Attitude
☐ Awareness ☐ Machine/Tool Usage

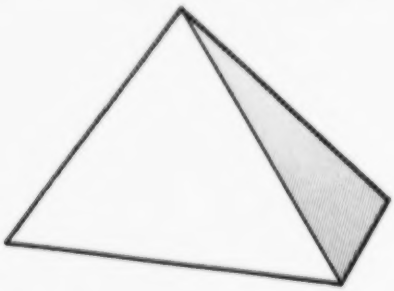
Redesign

Procedure

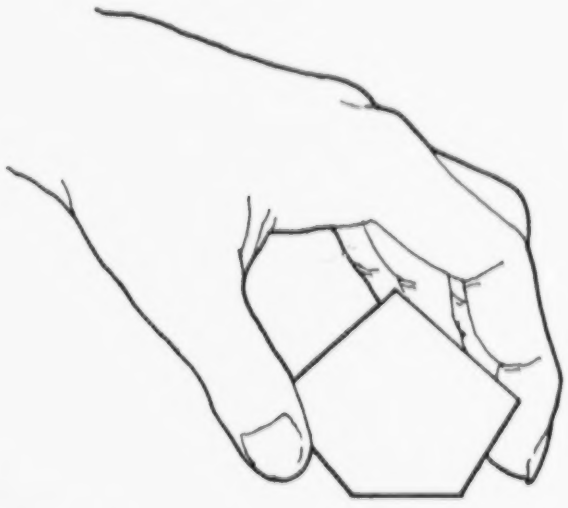
We usually buy and use products that work quite well just as they are, but occasionally further improvements or additions make them work even better. For example, it is often necessary or desirable to wrap a baseball bat or hockey stick with tape in order to be able to grip it better or to make it stronger. When you make this addition to the hockey stick or baseball bat, you are completing a design and making it more functional or useful.

Sometimes additions are made to products in order to personalize them or to make them look more attractive to the owner. For example, some people like to add special features to their cars or to modify them in such a way that they look distinctive and more attractive.

Sometimes a product can be made to work better and to look better at the same time, with only minor changes. Consider, for example, the design of this paperweight.



The original design is simple and pleasing in appearance, and it would keep papers from blowing away. However, it might be difficult to pick up. To improve its usefulness (by making it easier to pick up), several changes and/or additions could be made. For example, the block could be changed from a plain pyramid to a pyramid with an undercut so that a person's fingers could more easily grasp it.

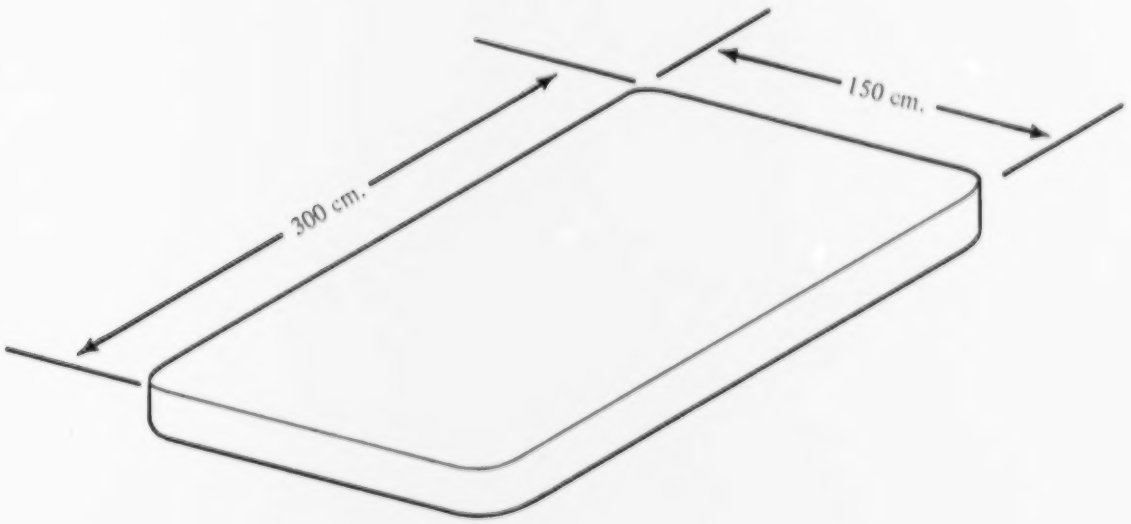


An additional piece could be added to provide a handle and to provide a pleasing contrast of materials if the handle were made of a different material from that of the base.

Notches could be cut to provide a place for the fingers to grasp.

All of these changes would improve the usefulness of the paper weight, and several of them would make it more interesting in appearance as well.

1. Now it's your turn to try your hand at improving and completing the design of a product. Beginning with a basic product, a combination cheese cutting and serving board, design provisions for easily gripping and carrying the board. Carefully examine the drawing of the cheese cutting and serving board. After you have looked at it carefully, think about ways in which it could be picked up and carried more easily. Sketch several alternatives (minimum of three) on the Student Response Sheet.



2. Select the idea or ideas you like best, and make a more detailed drawing of them on a separate sheet of paper. Include enough information on your drawing so little or no verbal communication needs to take place between you and your instructor. The instructor should be able to tell how you are planning to change the cutting board by studying your detailed drawing.

While you are working on this activity, keep in mind that almost all careers, hobbies, and occupations involve designing and redesigning to some degree. You will be redesigning, changing, improving, and repairing products throughout your life. For example, a cook might change a cooking recipe to suit tastes or diet; a hobbyist might customize an automobile for a car show; a package designer might be involved in redesigning a package to hold twelve soft drink cans.

If you are interested in this activity and think you would be interested in a job that involves designing and/or redesigning of products, you might consider the following careers:

pattern maker	plumber
tool and die maker	engineer
computer programmer	automobile body repair
urban planner	fashion designer

Redesign

Name _____

Class/Period _____

Preliminary Sketches

Sketch 1	Sketch 3
Sketch 2	Sketch 4

Final Drawing

(3C) Managed Activities

Manufacturing

Sample Enterprise Forms, to support the Managerial Processes concept, are not an activity by themselves. They have been developed to support and help organize an enterprise or manufacturing simulation unit, such as *Producing a Stepladder* (found elsewhere in this activity book).

MARKETING SALES RECORD

Company Name	Marketing Manager(s)

Qty.	Name of Buyer	Buyer's Address	Buyer's Phone Number	Date of Sale	Unit Price	Money Down	Balance to Pay	Delivered By & Date

MASTER BUDGET

Name	Date
Company	Budget Period

Sales Income ..... $ _____

Expenses:

Production Expenses

Materials ..... $ _____
Labor ..... _____
Overhead ..... _____
Total Production Expenses ..... $ _____

General Expenses

Marketing ..... $ _____
Administration ..... _____
Total General Expenses ..... $ _____

Total Expenses ..... $ _____

Profit (or Loss) Before Taxes ..... $ _____

BREAK-EVEN CHART

Company Name

Product	Date

Fixed Cost ..... $ _____

Variable Cost ..... $ _____

Selling Price Per Unit ..... $ _____

PROFIT/LOSS STATEMENT

Company Name
Profit and Loss Statement *Month/Day/Year*

Net Sales ..... $ _____

Cost of Goods Sold:

Materials ..... $ _____

Labor ..... $ _____

Overhead ..... $ _____

TOTAL Cost of Goods Sold ..... $ _____

Gross Profit (or Income) ..... $ _____

Less: Operating Expenses

Research and Development ..... $ _____

Marketing ..... $ _____

Administrative ..... $ _____

TOTAL Operating Expense ..... $ _____

Gross Operating Profit (or Income) ..... $ _____

Less: Depreciation ..... $ _____

Net Operating Profit (or Income) ..... $ _____

Add: Other Income ..... $ _____

Gross Income ..... $ _____

Less: Interest Expense ..... $ _____

Net Profit Before Taxes ..... $ _____

Less: Federal Income Taxes ..... $ _____

Net Profit ..... $ _____

BALANCE SHEET

Company Name
Balance Sheet *Month/Day/Year*

Assets:

Current Assets:

Cash ..... $_____

Accts. Receivable ..... $_____

Inventories:

Raw Materials ..... $_____

In-Process Materials ..... $_____

Finished Goods ..... $_____

Supplies ..... $_____

Total Current Assets ..... $_____

Fixed Assets:

Product Prototypes ..... $_____

Equipment ..... $_____

Total Fixed Assets ..... $_____

Other Assets:

$_____

Total Other Assets ..... $_____

TOTAL Assets ..... $_____

Liabilities:

Current Liabilities:

Accts. Payable ..... $_____

Notes Payable ..... $_____

Total Current Liabilities ..... $_____

Long Term Liabilities:

Bank Mortgage ..... $_____

Bonds ..... $_____

Total Long Term Liabilities ..... $_____

Net Worth (Owner's Equity):

Preferred Stock ..... $_____

Common Stock ..... $_____

Total Owner's Equity ..... $_____

TOTAL Liabilities and Equity ..... $_____

CAPITALIZATION REPORT

Company Name

Income

Owner's Equity ..... $ _____

Product Sales ..... $ _____

Other Income ..... $ _____

TOTAL Income ..... $ _____

Expenses

Cost of Materials ..... $ _____

Labor Cost ..... $ _____

Overhead Cost ..... $ _____

Marketing ..... $ _____

Administrative ..... $ _____

Research and Development ..... $ _____

Other Expense ..... $ _____

TOTAL Expense ..... $ _____

Gross Profit ..... $ _____

Less Owner's Equity ..... $ _____

NET PROFIT ..... $ _____

TOTAL Shares of Stock ..... $ _____

Dividends ..... $ _____ per share

_____ Liquidated as of the _____

Company Name — Month/Day/Year

Signature of Financial Manager	Date Signed
▶	

MATERIALS RECORD

Company Name	Materials Manager(s)

Qty.	Description of Item	Supplier	Date Requested	Date Ordered	Date Rec'd.	Unit Price	Total Cost

CHANGE ORDER

From:	To:

Change to be Initiated:

Reason for Change:

Date Initiated
Initiated By
Approved By

ROUTE SHEET

Company Name		Product
Prepared By		Part Name
Lot Size		Part No.
Date Started	Date Finished	Drwg. No.

Material Specifications

☐ Sub-Assembly ☐ Assembly

Event No.	Description of Event	Machine or Bench	Tool, Jig, or Fixture

WORK ORDER

Machine	Detailed Operational Procedures			
Operation No.				
Part Name				
Drwg. No.				
Jig/Fixture No.	Operator's Name	No. Prod.	No. Rejects	Time
Tool To Be Used				In Out
No. of Pcs.				In Out
Material Specifications				In Out
				In Out
				In Out
				In Out
Previous Work Station				In Out
Next Work Station				In Out
Set-Up Time				In Out
Time Per Piece				In Out
Remarks				In Out
				In Out
				In Out
				In Out
Filled Out By				In Out
				In Out

JIG AND/OR FIXTURE DESIGN

Designer's Name		Date
Product	Part Name	
Drwg. No.	Part No.	Operation No.
Jig/Fixture No.	Machine	Tool

Explain the function of the jig/fixture:

Materials Needed To Build the Jig/Fixture

Qty.	Item Description	Size	Available	Ordered	Cost

Approvals Needed:

Before you make: _____ Date: _____
Production Manager

After you make: _____ Date: _____
Quality Control

Sketch the jig/fixture on the back of this sheet. Do an isometric drawing with dimensions and specifications.

WORK STATION DESIGN

Operation No.	Part Name
Machine	Part No.
Bench	Number of Operators
Description of Operation:	
Scale	Drawn By

LEFT-HAND/RIGHT-HAND CHART

Present Method			Proposed Method
Operation		Operator's Name	
Dept.	Part Name		Part No.
Drawn By		Date	Page _____ of _____

Left Hand	Time		Symbols		Time	Right Hand

TIME STUDY SHEET

Observer's Name	Date
Operator's Name	Operation No.
Part Name	Part No.
Machine	

Readings In Work Cycles

Elements	a	b	c	d	e	f	g	h	i	j	Average Time
1.											
2.											
3.											
4.											
5.											
6.											
7.											
8.											
9.											
10.											
11.											
12.											

Foreign Elements		Total Time Per Cycle ▸	
Leveling Factor	Below Average.....90% Average.....100% Above Average.....110%	Rating Factor ▸	
		Adjusted Time ▸	
Allowance Factor	Fatigue Personal Preparation Delays	Total Allowance ▸	
Remarks		Standard Time ▸	

QUALITY CONTROL DESIGN SHEET

Designer's Name		Date
Product	Part Name	
Part No.	Drwg. No.	Inspection No.

Approval Needed:

Before you make: _____ Date: _____
Production Manager

Explain function of the item:

Materials Needed

Qty.	Item Description	Size	Available	Ordered	Cost

Approval Needed:

After you make: _____ Date: _____
Quality Control

Sketch the item on the back of this sheet. Do an isometric drawing with dimensions and specifications.

QUALITY CONTROL WORK ORDER

Inspection No.		Part Name
Drwg. No.	Part No.	Tolerance

Finished Dimensions, Shape, Finish, etc.	Inspection Gauge or Instrument

Inspection Procedure	Inspector	Time
		In Out
		In Out
		In Out
		In Out
		In Out
		In Out
		In Out
No. Inspected: _____		In Out
No. Rejected: _____		In Out
No. Reworkable: _____		In Out
		In Out
		In Out
		In Out
		In Out
		In Out
		In Out
		In Out
		In Out
		In Out

INSPECTION TAGS

Name _____

Date _____

REWORK

Directions _____

_____

_____

Signed _____

REJECT

Reason _____

_____

_____

Signed _____

REWORK

Directions _____

_____

_____

Signed _____

REJECT

Reason _____

_____

_____

Signed _____

PURCHASE REQUISITION

Company Name	Req. No.

Instructions: Complete in triplicate. Obtain approvals. Submit to Material's Manager.

Product		FOR OFFICE USE ONLY Order No. | Date Rec'd.
Department		**Approvals**
Requested From		**Material's Mgr.**
Dept. Foreman Approval	Prod. Mgr. Approval	**Finance Mgr.**

Qty.	Item Description	Recommended Source	Cost Per Unit	Total Cost
			Total Cost	$ _____

PURCHASE ORDER

Purchase Order No.	Date
Supplier	Ship and Bill To:

Qty.	Catalog Number	Item Description	Cost Per Unit	Total Cost
			Total Cost	$ _____

Terms	Invoice No.	F.O.B.
Delivery Date		Authorization *Finance Manager*
Final Approval By		

MATERIALS RECEIVING REPORT

To Financial Manager	Date	Order No.
Materials Received	Date	Report No.
Materials Received From		

Qty.	Description	Cost Per Unit	Total Cost
		Total Cost	$ _____

Signed *Materials Manager*	Date

Page _____ of _____

FINANCIAL JOURNAL

Company Name	Finance Manager

Entry Date	Item Description	Account Classification	Purchase Order No.	Debit		Credit		Balance	

SALES ORDER FORM

Customer Copy

Buyer's Name			
Address			Phone No.
Quantity	Name of Item	Unit Price	Total Sales
		$ _____	$
		Tax	$
		Total	$
Salesperson _____		Minus Down payment	$
Date Delivered _____		Balance Due	$

SALES ORDER FORM

Salesperson Copy

Buyer's Name			
Address			Phone No.
Quanitity	Name of Item	Unit Price	Total Sales
		$ _____	$
		Tax	$
		Total	$
Salesperson _____		Minus Down payment	$
Date Delivered _____		Balance Due	$

STOCKHOLDER'S RECORD

The following are stockholders of (insert company name)	During the months of to 19

Certificate Number	Date	Stockholder's Name	Address	Dividend Check No.